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SCHLOSBERG (M.) & BAKER (W. A.). **Tests of Sweet Corn Lines for Resistance to European Corn Borer Larvae.**—*J. agric. Res.* **77** no. 5 pp. 137–156, 10 refs. Washington, D.C., 1948.

The following is substantially the authors' summary. Tests were conducted at Toledo, Ohio, in 1935–41 [*cf. R.A.E.*, A **28** 177] and at Lafayette, Indiana, in 1942 to determine the inbred lines of sweet maize resistant to larvae of *Pyrausta nubilalis*, Hb. The material for investigation consisted of experimental and released lines of United States origin. In addition to natural infestation, the plants were uniformly infested by hand with egg-masses of *P. nubilalis*, and they were dissected for borer counts when the larvae were approximately full grown. The effects on the counts of known variable conditions of test were corrected by multiple-regression methods, and the results are expressed in terms of the percentage deviations of the observed from the predicted numbers of borers, which afforded the basis for evaluating the test lines.

Of 977 sweet maize inbreds examined for inherent resistance to the larvae, none showed immunity, but 44 manifested some resistance, having from 42 to 2 per cent. fewer borers than were predicted for them after tests extending over a period of three or more years. The results obtained from single crosses indicated incomplete dominance of either resistance or susceptibility. The intercrosses of resistant and susceptible parents generally showed results intermediate between those obtained for crosses within resistant and susceptible groups of inbreds. Although relatively low in inherent resistance, the discovered materials constitute resistant stocks of possibly differing factors for breeding strains of greater resistance. High resistance is probably due to the cumulative effects of several factors.

The 39 inbred lines of sweet maize consistently showing some resistance are enumerated. A further four lines showed apparent resistance when tested in 1935–39, when the single generation of *P. nubilalis* predominated, but apparent susceptibility in 1940–42, when the multiple-generation strain predominated [*cf. R.A.E.*, A **37** 155]. An opposite trend was shown by another inbred type for the two test periods. In the absence of critical research, a premise of differential reaction of the same lines of sweet maize to infestation by the different strains of the borer must be viewed with caution.

JEPPSON (L. R.) & MACLEOD (G. F.). *Lygus* **Bug Injury and its Effect on the Growth of Alfalfa.**—*Hilgardia* **17** no. 4 pp. 165–182, 4 pls., 1 fig., 21 refs. Berkeley, Calif., 1946.

The authors review divergent opinions as to the extent of the injury caused by Mirids of the genus *Lygus* to the vegetative growth of lucerne [*R.A.E.*, A **22** 295 ; **27** 463 ; **29** 567] and give an account of greenhouse tests in California on the effect on the total growth of lucerne plants of feeding by *L. hesperus*, Knight, and *L. elisus*, Van D., collected from lucerne in the field and on the nature of the feeding injury to the plant tissues.

The following is virtually their summary. Histological sections of lucerne tips from stems 2–4 ins. high, taken 2–4 days after being artificially infested with *Lygus* bugs, showed large areas of cell disintegration of the terminal and lateral bud primordia. Longitudinal sections of uninjured lucerne tips 2–4 ins. high showed lateral bud primordia in progressive stages of development at successively lower transverse planes than the terminal meristem, whereas tips sectioned four days after having been infested showed well-developed lateral buds at the same transverse plane as injured terminal buds. This condition indicates that a retardation of growth had resulted, with the lateral bud in the process of substitution for the injured terminal region. Discoloration and

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disintegration of the tissue surrounding the point of penetration by the bug stylets through young protective leaves, which enclose the terminal meristem, were confined to a small area round the stylet punctures.

The daily growth increment of lucerne plants, as measured by fresh or dry weight in comparison with uninfested plants, was consistently reduced by infestation with 6, 8 or 16 bugs. Plants infested with two or four bugs were reduced 30–60 per cent. in daily growth increment, when the bugs were introduced within four days from the time of cutting. In five of six periods, when 1–4 bugs were confined on lucerne plant stems after they were 6–10 ins. high, growth rate was not significantly less than for uninfested plants. A decrease of growth as a result of an infestation of *Lygus* bugs during one period did not substantially influence the growth rate of the plants during the succeeding period.

FRAZIER (N. W.) & SMITH (L. M.). **The Willamette Mite on Grapes.**—*Hilgardia* **17** no. 4 pp. 189–196, 6 refs. Berkeley, Calif., 1946.

The following is substantially the authors' summary. *Tetranychus willamettei*, McG., is an important pest of grape vines in California. The injury to foliage caused by its feeding appears to weaken the vines, with resultant loss in quantity and quality of crop. In the northern San Joaquin Valley and in the Sacramento and Sonoma Valleys, the mite has not been found in hibernation, but observations in the southern San Joaquin Valley showed that the females hibernate under bark on the branches of the vines and migrate to the immature foliage in spring, soon after the buds have burst. Oviposition began about 15 days after this migration, the eggs hatched in about a week, and the first-generation adults appeared ten days later. Overwintered adults were still present on the leaves 32 days after the spring migration, but not 53 days after it. All stages were present on foliage as late as 1st November, and migration from foliage to hibernation quarters was in progress on 30th November. Banding the bases of the spurs with an adhesive in early spring may be a means of control.

Service and Regulatory Announcements, October 1947–March 1948.—*S.R.A., B.E.P.Q.* nos. 170–171 pp. 111–129, 1–19. [Washington, D.C.] U.S. Dep. Agric., 1948.

The first of these parts (B.E.P.Q. no. 170) includes summaries of the current domestic and foreign plant quarantines applying to the continental United States, Hawaii and Porto Rico and of other restrictive orders under the Plant Quarantine Act [*R.A.E.*, A **17** 163] and supplements to summaries already noticed of restrictions in Belgium [**26** 134] and Mexico [**25** 286]. It also contains an announcement relating to the fruit and vegetable quarantine (no. 56) in the United States authorising the refrigeration treatment applied in transit to imported grapes and certain other deciduous fruits against the Mediterranean fruit-fly [*Ceratitis capitata*, Wied.] [**26** 229] also to be carried out by maintaining them at a temperature of 36°F. or below for 16 days.

The second part (B.E.P.Q. no. 171) includes a revised digest of plant-quarantine import restrictions in France and a supplement to a summary already noticed of restrictions in Chile [**29** 349].

Nursery Stock, Plant and Seed Quarantine No. 37.—*U.S. Dep. Agric. B.E.P.Q.*, Q. 37, 15 pp. [Washington, D.C.] 1949.

This is a revision of a quarantine (no. 37) designed to prevent the entry into the United States, Alaska, Hawaii, Porto Rico and the U.S. Virgin Islands from foreign countries of injurious plant pests not already present there. It prohibits the importation, except by the Department of Agriculture for

scientific purposes, of specific nursery and other plant stock and seeds from specified countries and restricts the entry of all other seeds and propagative material, plants and plant products. These are subject to inspection and, where necessary, treatment by authorised methods to free them from plant pests. They must be packed in approved materials and, except in the case of material from Canada, be free from sand, soil or earth. With certain specified exceptions, they also require a permit and must be accompanied by a certificate from the country of origin. Seeds must be free from pulp capable of supporting living injurious insects other than those that attack stored products. Except in specified cases, forest trees, plants used for understocks and ornamental plants that grow true from seed may be imported only as seeds. Trees, shrubs and ornamental perennials are limited with regard to age and size, and some from specified countries are required to be grown under post-entry quarantine conditions. No living insect notoriously injurious to cultivated crops may be imported, except under permit for scientific purposes.

TREHAN (K. N.) & PINGLE (S. V.). **Chaemotropic Response of Fruit Flies.**—*Proc. Indian Acad. Sci.* Sec. B **23** no. 6 pp. 260–265, 2 figs., 13 refs. Bangalore, 1946.

The results are given of investigations on the efficacy of bait-traps for the control of fruit-flies carried out in Poona in 1937–40. Preliminary tests showed that Clensel " A " was slightly more attractive than Clensel " B " or a mixture of ammonia and vanilla and that citronella oil attracted males only. Investigations were therefore confined to Clensel " A ", and a concentration of 1 : 30 was found to be at least as effective as stronger ones. In cucurbit fields, practically all the species of fruit-flies were trapped, but there were about ten times as many of *Dacus cucurbitae*, Coq., as of *D. zonatus*, Saund., whereas *D. ferrugineus*, F., predominated on fruit trees. About 60 per cent. of the total catch was made in April–July, the rise in numbers practically coinciding with a rise in the average minimum temperature. Trapping did not appreciably reduce the damage caused, however, even when used on a large scale.

Entomological Section.—*Rep. Indian Lac Res. Inst. Namkum 1944–45* pp. 12–27. Ranchi, 1945.

Investigations on *Bracon* (*Microbracon*) *greeni*, Ashm., which parasitises *Eublemma amabilis*, Moore, one of the predators of the lac insect [*Laccifer lacca*, Kerr] were continued at Namkum, Bihar, in 1944–45 [*cf. R.A.E.*, A **34** 164]. Experiments in every month in the year in which it was bred at controlled humidity and temperature or under uncontrolled laboratory conditions, mainly on *E. amabilis*, showed that the temperature within a certain range is more important for its development than humidity. The percentage parasitism was rather low. In attempts to breed *B. greeni* on a large scale in the laboratory the hosts tried were *E. amabilis*, *Platyedra gossypiella*, Saund., *Leucinodes orbonalis*, Gn., *Scirpophaga nivella*, F., *Emmalocera depressella*, Swinh., the ant, *Cataglyphis bicolor*, F. [*cf.* **27** 129], and two unidentified borers, one [*Enarmonia perfricta*, Meyr.] from the seeds of *Pongamia glabra* and the other [*Trachylepidia fructicassiella*, Rag.] from pods of *Cassia fistula*. Breeding was handicapped by lack of suitable equipment to control temperature and humidity, but was successful on all the hosts offered except *Emmalocera*. Preliminary tests to determine the oviposition response of the parasites to such stimuli as size, texture and odour of the host indicated that the odour of the host larva and the dome-shaped covering associated with it [*cf.* **34** 165] are dominant factors in the initial attraction from a distance.

Releases of *B. greeni* once a week caused a reduction in the population of *E. amabilis* in three of the four lac crops and in all four the average mean percentage parasitism was more than twice as great in treated as in untreated areas. Investigations on the control of insect enemies of *L. lacca* by heat treatment of stick lac [*cf.* **34** 165] indicated that a higher minimum temperature than 52°C. [125·6°F.] and a longer exposure than six hours were necessary for optimum results. Chemical analysis showed practically no difference between shellac obtained from the untreated lac and that treated by heat.

Breeding of the parthenogenetic strain of *L. lacca* [*cf.* **34** 165] was discontinued after the eleventh generation had developed normally.

Entomological Section.—*Rep. Indian Lac Res. Inst. Namkum 1945–46* pp. 19–32. Ranchi, 1946.

Investigations carried out at Namkum, Bihar, in 1945–46, in which stick lac was enclosed in a cage of 60-mesh wire-gauze, showed that this prevents the escape of almost all the insect enemies of the lac insect [*Laccifer lacca*, Kerr] but not of the young brood of *L. lacca*. Experiments on the control of natural enemies by immersion of stick lac in cold water for a few days or hot water (50–60°C. [122–140°F.]) for a few hours or by heat treatment in a closed room at 50–68°C. [122–154·4°F.] for eight hours [*cf.* preceding abstract] indicated that the cold-water treatment [*cf. R.A.E.*, A **31** 295, 453] was the most effective.

In further attempts to find alternative hosts on which to breed *Bracon greeni*, Ashm. [*cf.* preceding abstract], 17 insects were tested and *Platyedra gossypiella*, Saund., *Scirpophaga nivella*, F., *Trachylepidia fructicassiella*, Rag., and *Enarmonia perfricta*, Meyr., appeared to be suitable. Attempts to breed large numbers of *T. fructicassiella* and *P. gossypiella* in the laboratory were unsuccessful. To ensure that larvae of *T. fructicassiella* should remain in the lac dome for parasitism, it was necessary to amputate the mouth-parts or paralyse the larvae by putting them in water at a temperature of 46°C. [114·8°F.] for about six minutes. To attract the parasite, a mixture of fresh pellets of excreta of *Eublemma amabilis*, Moore, and finely powdered stick lac was pasted in a thin layer on tissue paper covering the domes. The breeding of *B. greeni* on all hosts from April to September was hampered by infestations of mites. Paralysing larvae of *T. fructicassiella* in hot water eliminated infestation by mites from this host, and the most successful method of freeing the lac domes and parasite cages from mites was to expose them to a temperature of 56°C. [132·8°F.] for six hours.

Since larvae of *E. amabilis* are generally scarce from January to June, 30,000 were stored at 16–18°C. [60·8–64·4°F.] in November. To determine the effect of cold storage on the larvae, 100 larvae on natural sticks and 100 loose with scraped lac in a glass vessel were kept in the same cold chamber, and it was found that survival was fairly high after two months in natural sticks, but lower in loose scraped lac. When *Eublemma* larvae from cold storage and those collected in the field were offered to *B. greeni* for oviposition, the percentage parasitism, number of adults bred per host and percentage of females were all lower in the former. When *Eublemma* larvae were offered for oviposition in natural lac sticks, in lac domes with a covering of natural spun web and in lac domes covered with tissue paper, parasitism was highest in the first case and lowest in the last. During the winter and summer months, parasitism is reduced in the laboratory, and breeding was therefore carried out under conditions of controlled temperature from December to March. Tests were made at average temperatures of 70, 75, 83 and 86°F., and the percentage parasitism was highest (80) at 86° and lowest (46·3) at 75°.

Negi (P. S.), Gupta (S. N.), Misra (M. P.), Venkatraman (T. V.) & De (R. K.). **Relative Importance and Practicability of various Methods of Control against Insect Predators and Parasites of the Lac Insect.**—*Bull. Indian Lac Res. Inst.* no. 63, 12 pp., 11 refs. Ranchi, 1945.

The authors give a short account of the life-history and cultivation of the lac insect, *Laccifer lacca*, Kerr, at Namkum (Bihar), state that in average crops about 40 per cent. of the population is destroyed by other insects [*cf. R.A.E.*, A **31** 453] and give lists of the species responsible, showing their alternative hosts, when known. Predators, comprising *Eublemma amabilis*, Moore, *Holcocera pulverea*, Meyr., *Chrysopa* spp. and three minor species of Lepidoptera, cause 90 per cent. of the loss and nine species of parasites the rest. Notes are given on the bionomics of the major predators and the parasites, and hyperparasites on the latter are shown. To reduce the loss, only brood lac comparatively free from natural enemies should be used, brood lac swarming at different seasons or at an interval of more than 21 days should not be used in the same area, natural infestation by *L. lacca* should not be allowed, as it makes it impossible to remove the old crop until the next one is ready, and brood lac used for infesting host trees should be taken down as soon as the brood has left it (after 2–3 weeks). All freshly cut lac sticks that are not required for brood and all brood lac that has been used should be scraped immediately and if possible converted into seed lac, as the scraping and washing processes destroy the predators and parasites. Wire-gauze or woven grass or bamboo baskets can be used to contain the brood lac placed on trees, so that natural enemies are retained [*cf.* preceding abstract], but this method is rather expensive. Fumigating all scraped lac with 1 oz. carbon bisulphide per 10 cu. ft. space before storage and keeping all lac sticks under water for 3–4 days [*cf.* preceding abstract] destroy predators and parasites.

It is not feasible to control the parasites of *L. lacca* by means of hyperparasites since these frequently attack *L. lacca* itself or each other, but the parasites of the predators do not have this disadvantage. A list is given of 13 that attack *Eublemma*, *Holcocera* or both and two ants that are predacious on both of them. Unfortunately, they are not numerous. Those that it might be useful to liberate in large numbers comprise *Trichogrammatoidea nana*, Zehnt., which parasitises the eggs of both species, *Elasmus claripennis*, Cam., and *Bracon* (*Microbracon*) *greeni*, Ashm., which are ectoparasites of *Eublemma* larvae, *Apanteles tachardiae*, Cam., an endoparasite of *Holcocera* larvae, *Pristomerus testaceicollis*, Cam., an endoparasite of both species, and a Bethylid ectoparasite of *Holcocera* larvae. Releases of *B. greeni* have proved encouraging [*cf.* **37** 228]. The comparative efficiency of the different methods of control is discussed.

Anderssen (E. E.). **Controlling the Maize Stalk-borer with D.D.T.**—*Fmg in S. Afr.* 1946 repr. no. 63, 2 pp. Pretoria, 1946.

In 1945, the maize stalk-borer [*Busseola fusca*, Fuller] destroyed 90 per cent. or more of the crop in some maize fields in South Africa, and extensive laboratory and field tests were therefore carried out with a dust of DDT in talc, used as a top dressing. This treatment gave excellent results against all stages of the larvae at concentrations as low as 1·5 per cent. DDT, but a 5 per cent. dust is recommended. Only plants in the funnel stage of growth are suitable for treatment, but all plants in that stage, irrespective of height, can be treated. The method is effective against attacks that occur through the funnel but not against those through the side of the stalk ; early in the season almost all infestation takes place through the top [*cf. R.A.E.*, A **32** 231].

The smallest amount of dust that can be applied is sufficient ; most of it falls into the funnel, but a little falls on the outer leaves round the funnel,

and this slight overflow is an advantage. At least 1,200 plants can be treated with 1 lb. powder, and the only equipment required is a fairly large container slung over the shoulder for holding the dust, and a scoop with a handle for applying it. The most suitable scoop is a cylindrical one with upright sides, 1½–2 inches in diameter and about 2½ inches deep. The application should be carefully timed. The initial infestation results in severe stunting of random plants with considerable speckling of the leaves. From these plants the young larvae migrate to neighbouring plants and enter them by way of the funnel. Plants that become infested by migration are not stunted and show less discoloration. If this migration is allowed to proceed for a week or ten days and the DDT applied then to every plant, the period of protection will be extended to its maximum, the residual action of the DDT for 2–3 weeks and the period of delay giving a total period of about five weeks during which the insect is prevented from doing serious damage and from developing to the adult stage. Regular and careful inspection of the crop is necessary to prevent excessive delay in making the application, which would result in severe damage. Rain tends to wash the powder back into the throat of the plant and, unless torrential, improves rather than reduces the efficacy of the treatment.

Extensive feeding tests and chemical analyses showed that DDT applied in this manner to maize does not constitute a danger to stock. No harmful effects on the plants were apparent, and pollination was not noticeably affected.

Plants that have been cleared of infestation in the funnel stage and have formed cobs may be reinfested from neighbouring untreated fields, and as such infestation in cobs and stalks cannot be treated by top dressing, the only way of obtaining complete protection is to treat all the maize in the neighbourhood.

STOFBERG (F. J.). **Pumpkin-fly as a Pest of Granadillas.**—*Fmg in S. Afr.* 1946 repr. no. 73, 4 pp., 3 figs. Pretoria, 1946.

Since granadilla [*Passiflora*] has been cultivated extensively in the Transvaal lowveldt, considerable losses of fruit have been caused by insect damage. No insects could be reared from mature damaged fruits, but when sting marks on young fruits were opened, eggs and in some cases a few fly larvae were found. Larvae that hatched from the eggs fed little if at all and died or left the fruits in a few days. Feeding is apparently inhibited by a hard swelling that develops in the rind. A female of *Dacus vertebratus*, Bez., was later observed ovipositing in a young fruit, and the typical injury developed two days later. The same occurred when females of this fruit-fly reared from squash were caged with young fruits. According to records in the National Collection of Insects, it appears that *D. bivittatus*, Big., and *Ceratitis capitata*, Wied., have been reared from granadillas under certain conditions, and it is possible that *D. ciliatus*, Lw., and *C.* (*Pterandrus*) *rosa*, Karsch, cause similar injury.

The fruits are attacked while very young and usually drop within a few days. When fruits ½–¾ in. in diameter are attacked, some shrivel and drop and others continue to grow till mature, but with the typical injury spot on them. In some instances a fungus (*Ascochyta* sp.) grows on the affected spot. The appearance of the damaged fruit is described. The oviposition puncture does not normally penetrate the rind, but seeds do not develop at that point, and although the rest of the fruit develops normally it is not well filled and has a bad appearance. The damage is usually most severe in spring and occasionally in late autumn.

Control measures consist in sprinkling droplets of a poisoned bait [*R.A.E.*, A **23** 183] over the foliage once a week from the beginning of flowering until all the fruit is set, and also immediately after every shower that removes the bait. Since the fruit-flies breed in large numbers in cucurbits, granadillas should be planted at a good distance from them.

JARY (S. G.). **Good Control of Insect Pests.**—7×4½ ins., pp. xi, 13–216, 18 figs. London, Hodder & Stoughton, Ltd. for Engl. Univ. Press, Ltd. (Teach Yourself Farming Books), 1948. Price 4*s.* 6*d.*

About a quarter of this hand-book is concerned with the nature, properties and application of the commoner insecticides, and about half is devoted to descriptions of the direct damage caused in Britain to agricultural crops, fruit, hops, vegetables and flowers, by specific insects, mites and other invertebrate pests, and instructions for their control. The pests are arranged under the plants attacked, and only their popular names are given. An account of the structure and development of insects, with notes on other invertebrate pests, is given in an introductory chapter, and factors influencing the behaviour and survival of insects under natural and agricultural conditions and the directions along which existing methods of control may be improved and others developed are discussed in a concluding one.

JAMESON (H. R.), THOMAS (F. J. D.) & WOODWARD (R. C.). **The practical Control of Wireworm by γ-Benzene Hexachloride ("Gammexane"): Comparisons with Dichlorodiphenyltrichlorethane (D.D.T.).**—*Ann. appl. Biol.* **34** no. 3 pp. 346–356, 2 refs. London, 1947.

The following is largely the authors' summary. Benzene hexachloride was used successfully in powder and granular form in a number of field trials in southern England in the control of wireworms. On heavily infested land, the effective dosage rates associated with an appreciable reduction in wireworm population, a marked improvement in the establishment of winter wheat and spring oats and substantial increases in yield, ranged between 1 and 6 lb. (2–12 oz. γ isomer) per acre. The effective dosage rate of γ isomer was about three times as high when the insecticide was broadcast on the seed-bed as when it was combine-drilled with the seed or used as a seed dressing. Application by combine drilling and broadcasting resulted in a greater reduction in wireworm populations than seed dressing, but the latter method resulted in increased yields and there is stated to be no appreciable difference in the results obtained by the three methods. When a fertiliser was applied with granular benzene hexachloride and seeds of oats sown in spring by means of a combine-drill, the yield was considerably increased, though in general wireworm populations were reduced less than where the fertiliser was omitted. DDT applied by similar methods was associated with similar reductions in wireworm populations, but resulted in smaller increases in yield.

HEWLETT (P. S.). **A Direct-spray Technique for the biological Evaluation of Pyrethrum-in-oil Insecticides for Use against Stored Product Insects in Warehouses.**—*Ann. appl. Biol.* **34** no. 3 pp. 357–375, 1 pl., 6 figs., 17 refs. London, 1947.

A solution of pyrethrins in a heavy, highly refined, mineral oil (Shell oil P 31) is now largely used as a spray for the control of insects infesting food stores in Britain, and it is considered that most of the mortality of the insects is due to contact with the film deposited. In fact, however, the toxicity of films of this insecticide on materials commonly used in buildings is low [*R.A.E.*, A **37** 47–48], and direct spray effects must be of importance. A method for measuring these effects, using adults of *Tribolium castaneum*, Hbst., as test insects, was therefore devised and is described in this paper, with the experiments that led to its adoption. It resembles as closely as possible the method for the measurement of the toxicity of films devised by Parkin & Green [**31** 85; **32** 182], so that direct comparisons of the results obtained by the two procedures can be made, but incorporates several improvements and reduces the film effects

to the minimum practicable. It consists in applying a measured quantity of spray to insects confined on filter paper by means of a duralumin ring surrounded by a brass mask covering the exposed edge of the filter paper, substituting a dry, brass ring for the mask, removing the wet duralumin ring, and gently brushing the insects into a container comprising a glass ring standing on dry filter paper, in which they are kept at a temperature of 25°C. [77°F.] and a relative humidity of 70 per cent. Mortality counts are made after six or nine days and analysed statistically by methods that are discussed. This method is slightly superior to the film technique for the biological assay of pyrethrins in Shell oil P31, but the two methods should be regarded as complementary in general experimental work.

Posnette (A. F.). **Virus Diseases of Cacao in West Africa. I. Cacao Viruses 1A, 1B, 1C and 1D.**—*Ann. appl. Biol.* **34** no. 3 pp. 388–402, 2 pls., 1 fig., 29 refs. London, 1947.

Crowdy (S. H.) & Posnette (A. F.). **Virus Diseases of Cacao in West Africa. II. Cross-immunity Experiments with Viruses 1A, 1B and 1C.**—*T.c.* pp. 403–411, 2 figs., 9 refs.

The first paper contains a brief account of the history of the swollen-shoot disease in the Gold Coast, a discussion of the nomenclature of the viruses or strains of a virus complex associated with it [*R.A.E.*, A **35** 88; **37** 85] and information, some of which has already been noticed [**37** 85, 86], on the distribution, synonyms, and properties of four of them, together with the symptoms they produce and lists of their vectors (*Pseudococcus* spp. and *Ferrisia virgata*, Ckll.). These four are termed strains A, B, C, and D of cacao virus 1 without prejudice to their possible relationship as distinct viruses or strains of the swollen-shoot virus. The properties dealt with in general include cross-immunity reactions, latent period, staining reaction, rate of spread and seed transmission. *F. virgata* has been found to transmit B as well as A [*cf.* **37** 85, 86]. In addition, the symptoms caused by the mild form of A known as attenuated A [**37** 86] are described, and notes are given on its cross-immunity reactions and latent period.

The second paper contains the results of experiments on the cross-immunity reactions of strains A, B and C and their effect on yield [*cf.* **37** 86], and on their rate of spread. Significant differences were found in the rates of spread from plot to plot. The virulent A spread more rapidly than the apparently harmless B, but C spread most slowly, suggesting that its vectors are less effective in transmitting it or that they were less active or less abundant than those of A and B.

Kassanis (B.). **Studies on Dandelion Yellow Mosaic and other Virus Diseases of Lettuce.**—*Ann. appl. Biol.* **34** no. 3 pp. 412–421, 2 pls., 8 refs. London, 1947.

The following is almost entirely the author's summary of studies on virus diseases of lettuce in England. The symptoms caused by dandelion yellow mosaic [*R.A.E.*, A **34** 70] in cultivated lettuce (*Lactuca sativa*), *Lactuca serriola* and *L. virosa* are described and compared with those caused by lettuce mosaic virus. Lettuce is much more susceptible to the yellow mosaic virus than dandelion (*Taraxacum officinale*); no infections of dandelion were obtained by mechanical inoculation and only three by Aphids, whereas infection of lettuce is regularly obtained by Aphids and by inoculation provided that an abrasive is used. *Myzus ornatus*, Laing, *M. ascalonicus*, Doncaster, and *Macrosiphum* (*Aulacorthum*) *solani*, Kalt., transmitted dandelion yellow mosaic virus but not lettuce mosaic virus, whereas *Myzus persicae*, Sulz., transmitted the latter but

not the former. *Myzus* (*Nasonovia*) *ribicola*, Kalt., the common lettuce Aphid, transmitted neither, and *Myzus* (*Aulacorthum*) *circumflexus*, Buckt., *Macrosiphum solanifolii*, Ashm., *Aphis* (*Doralis*) *fabae*, Scop., and *Pemphigus bursarius*, L., all failed to transmit dandelion yellow mosaic. Aphids became infective only after feeding periods of some hours on the diseased plants and ceased to be infective within an hour of the infective feeding. Their efficiency as vectors was not increased by a preliminary starving period, as happens with *Myzus persicae* and lettuce mosaic virus. Lettuce mosaic virus was found in most samples of commercial seed, which explains its prevalence ; no evidence was found for the seed-transmission of dandelion mosaic virus and it is doubtful if it occurs, for infected lettuce are so severely affected that they rarely set seed.

Cucumber mosaic virus, which has been shown to be transmissible to lettuce by inoculation, was isolated from naturally infected lettuce on three occasions, and was found to be quite readily transmitted to lettuce by *M. ornatus*, which has not hitherto been regarded as a vector. The symptoms that developed under greenhouse conditions during winter on lettuces of different varieties are described. On the young leaves of some, they resemble those of lettuce mosaic, and it is probable that many records of this disease should refer to cucumber mosaic.

McKeen (C. D.). **An Occurrence of Soft Rot in Peppers and its Relation to the Corn Borer.**—*Sci. Agric.* **28** no. 3 pp. 142–143, 1 fig., 1 ref. Ottawa, 1948.

In late August and early September 1947, some of the fruits of peppers [*Capsicum*] in all plantings in a district in southern Ontario developed soft rot, the symptoms of which are described. Both sweet and hot varieties were affected, and as many as four or five capsules on a single plant were diseased, although surrounding plants might not be infected. *Erwinia carotovora* was isolated from fruits in incipient and later stages of the rot, and inoculation of it reproduced the disease in wounded fruits but not in undamaged ones. During August, larvae of *Pyrausta nubilalis*, Hb., were noticed in some of the fruits, and examination of many fruits in September showed that the larvae were present in some healthy ones, all of those showing incipient rot, and none of those in which the decay was extensive. It is concluded that the pathogen infected tissues damaged by the larvae, and was disseminated by them as they moved from partly rotted to uninfected fruits.

Platt (A. W.), Farstad (C. W.) & Callenbach (J. A.). **The Reaction of Rescue Wheat to Sawfly Damage.**—*Sci. Agric.* **28** no. 4 pp. 154–161, 2 figs., 1 ref. Ottawa, 1948.

The following is virtually the authors' summary. The reaction of the new solid-stemmed, hard, red spring wheat, Rescue, to damage (stem-cutting) by *Cephus cinctus*, Nort. [*cf. R.A.E.*, A **37** 108] was studied. In nursery trials in Alberta and Saskatchewan, during the period 1943–47, Rescue showed a high degree of resistance at four stations. At the fifth station, its resistance was not high in any year, and it was almost completely susceptible in one year. In 22 trials in south-western Saskatchewan in 1946–47, its resistance was satisfactory. Field observations in Alberta and Saskatchewan were in agreement with the results from the nursery trials. Nursery trials were conducted at eight stations in Montana in 1945, four in 1946, and 13 in 1947. The resistance of Rescue was good at six and fair at two in 1945, good at three and fair at one in 1946, and good at six, fair at two and unsatisfactory at five in 1947. In contrast to the nursery results, all the field plantings of Rescue examined in 1946–47 showed high resistance. The reasons for fluctuations in damage are not known.

WEISSER (J.) & GOODEN (E. L.). **Particle-size Reduction of DDT in grinding with Diluents.**—*Agric. Chem.* **2** no. 8 pp. 28–29. Baltimore, Md., 1947.

The following is taken from the authors' summary. A method is described for obtaining some measure of the particle-size reduction of DDT on grinding with diluents. It has been applied to a series of 12 diluents, ten of which are commonly used as carriers for insecticidal materials. While the results show great variability from one diluent to another, they show also that all the diluents studied give considerable reduction in particle size of the DDT.

LANGE (W. H.). **New Developments in Soil Insecticides.**—*Agric. Chem.* **2** no. 9 pp. 20–23, 68–69, 71, 6 figs., 25 refs. Baltimore, Md., 1947.

The author reviews recent literature on the use of chemicals for soil treatment against insects and other organisms injurious to crop plants. Those dealt with individually are 1,2-dichlorpropane (propylene dichloride), D-D mixture (1,2-dichlorpropane and 1,3-dichlorpropene with small amounts of other lighter and heavier saturated and unsaturated hydrocarbons), methyl bromide, ethylene dibromide, ethylene dichloride, benzene hexachloride, and DDT. He also reports that in preliminary tests in California he found technical chlordane to be very effective for the control of wireworms when used at the rate of 10 lb. per acre in 20 U.S. gals. of a solvent such as benzene. It was drilled into the soil to a depth of six inches at intervals of 12 inches.

Soil fumigants have often been observed to increase the growth and yield of a crop more than would be expected on the basis of the kill of insects given by them. The effect of different soil fumigants on the soil is not fully known, but a few of the reasons for crop stimulation following their use include the effect on the chemical and physical properties of the soil, particularly a change in soluble soil constituents, some effect on soil fertility, such as an increase in ammonia content, and an increase in the bacteria of the soil owing to the killing of harmful protozoa. In addition to the effects of partial sterilisation, increased yields after the use of some volatile chemicals are due to the restoring of a more favourable biotic complex. The factors that determine the effectiveness of soil fumigation under a particular set of conditions include soil temperature, the type, composition, compactness and moisture content of the soil, the amount of fumigant used, adsorption, the correlation of time of treatment with the known behaviour of the organism to be killed, and the type of sealing used after treatment.

CHISHOLM (R. D.) & KOBLITSKY (L.). **Effect of Light on DDT Residues.**—*Agric. Chem.* **2** no. 9 pp. 35, 37, 7 refs. Baltimore, Md., 1947.

Investigations on the effect of heat and sunlight on DDT residues are described. Petri dishes dusted with recrystallised and technical DDT at the rate of about 3 mg. per sq. cm. were weighed before, during and after exposure in an oven at 112°F. for 72 hours. The weight of the deposit of recrystallised DDT was found to decrease by about 0·25 per cent. during heating, about three quarters of the loss occurring in the first 24 hours, and that of the technical DDT by a little less than 1·5 per cent., about half the loss occurring in the first 24 hours. The colour of the deposits remained unchanged. To test the effect of sunlight, recrystallised and technical DDT were mixed with equal weights of pyrophyllite, and the mixtures were micronised or brushed through a 100-mesh sieve and dusted on tared glass plates, which were weighed and covered with uncoated perforated cellophane and exposed for a total of 64 hours during summer on calm days when the sun was brightest. The percentage losses of weight were 9·3 and 3·4 for micronised and sieved mixtures of recrystallised DDT and 20·3 and 22 for the corresponding mixtures of technical DDT, showing

that DDT is lost from deposits on exposure to sunlight at summer temperatures. Comparison of these results with those obtained in the oven showed that the loss of weight was accelerated by sunlight.

In another test, recrystallised or technical DDT was ground with approximately equal weights of a clay, a diatomaceous earth, Bordeaux mixture (1 : 1), ferric dimethyl dithiocarbamate, hydrated lime, limonite, pyrophyllite or crude sulphur, and the mixtures were brushed twice through a 100-mesh sieve and wetted with a 0·1 per cent. aqueous solution of a surface-active agent to form pastes. These were spread evenly on glass plates, allowed to dry and exposed to sunlight for 64 hours as before, after which the deposits were scraped from the plates, extracted with benzene, and analysed for total and hydrolysable chlorine. In most cases, the proportion of DDT in the uncovered paste deposits was less after exposure than in the original mixtures, indicating that DDT had been lost from them. The greatest decreases occurred in the deposits containing hydrated lime, possibly owing to increase in weight of the lime due to hydration while the mixtures were wet or to carbonation during exposure. The proportion of DDT in the sulphur deposits was greater after exposure than before, indicating that the sulphur volatilised more quickly than the DDT, particularly the crystallised grade ; this suggests that the use of a relatively volatile diluent for DDT may give deposits that provide for the uncovering of fresh DDT on volatilisation of the diluent and thus prolong the toxicity of the deposit. The ratios of hydrolysable chlorine to total chlorine in both the original and the exposed residues were over 2 : 10, indicating that DDT is compatible with the diluents under summer conditions. However, an indication of partial decomposition due to exposure was noted in the tan colour of the exposed dusts, particularly those containing technical DDT, suggesting that under field conditions decomposition may be limited to the exposed surfaces. Thus, reduction of toxicity to insects during exposure may not indicate that the components of a deposit are incompatible. The amounts of DDT determined in deposits containing no diluent were less after exposure than before, suggesting that part of the DDT may have decomposed or become partially insoluble in benzene.

HARRIS (J. S.). **Tetraethyl Pyrophosphate.**—*Agric. Chem.* **2** no. 10 pp. 27–29, 65–66, 2 figs., 9 refs. Baltimore, Md., 1947.

In this progress report on investigations on the use of tetraethyl pyrophosphate as an insecticide, the author discusses the structure of the molecule and describes the physical properties of the distilled compound. This is a colourless liquid that crystallises at a temperature below — 50°C. and boils at approximately 100°C. at a pressure of 0·01 mm. mercury, and 150°C. at 10 mm. mercury ; it decomposes at higher temperatures. It is miscible with water, acetone, alcohol, benzene, carbon tetrachloride, chloroform, diacetone alcohol, ethyl acetate, glycerine, orthodichlorbenzene, pine oil, toluene, xylene and alkylnaphthalenes, but not with kerosene, petroleum ether or other paraffinic oils. It is similar in both physical and chemical characteristics to hexaethyl tetraphosphate, but has an appreciably lower rate of hydrolysis, so that it retains its activity longer in the presence of moisture, though it is desirable to use spray solutions as soon as possible. It also has a higher vapour pressure, so that it can be distilled at reasonable pressures.

Both compounds are generally effective against Aphids and mites [*cf. R.A.E.*, A **36** 228 ; **37** 43]. Tetraethyl pyrophosphate has given commercial control of various insects at dilutions of 1 : 4,000 to 1 : 20,000, and in particular has given promising results against the two-spotted spider mite [*Tetranychus bimaculatus*, Harvey], the green chrysanthemum aphis [*Rhopalosiphum rufomaculatum*, Wils.], the pea aphis [*Macrosiphum onobrychis*, Boy.], the

green peach aphis [*Myzus persicae*, Sulz.], the plum curculio [*Conotrachelus nenuphar*, Hbst.], the sweet-clover weevil [*Sitona cylindricollis*, Fhs.], the rose sawfly [*Caliroa aethiops*, F.] and a rose aphis, *Myzus porosus*, Sand. Tests on a number of plants showed no injury when it was used at normal concentrations.

Acute toxicity tests on rats, mice and rabbits showed that it is extremely poisonous to mammals when introduced orally or absorbed through the skin, less than 0·04 ml. causing death when placed on the abdominal skin of a rabbit ; in field tests, suitable precautions must be taken to prevent exposure of the operator to solutions or vapours by ingestion, inhalation or skin absorption. Its mode of action is not fully known. It exerts a profound inhibition on cholinesterase in the bodies of mammals and insects as well as *in vitro* in extremely dilute solutions. When sufficient to cause death is introduced orally, it causes hyperexcitability, fine and coarse tremors, dyspnoea, extreme miosis, convulsions, collapse and finally respiratory failure. Anhydrous tetraethyl pyrophosphate was found to attack black iron, galvanised iron and tin plate at an appreciable rate, but nickel, stainless steel and aluminium showed little or no evidence of attack in preliminary tests. Glass and certain types of lacquer-lined iron containers were found to be quite satisfactory for storing it. Information is not available on corrosion in spray equipment, but the effect of the very dilute solutions used would probably be negligible on most materials. However, care should be taken to observe the effects of the solutions on any equipment used before assuming the resistance of the materials.

HENSILL (G. S.). **Insecticide Application by "Vapo-Diffusion".**—*Agric. Chem.* **2** no. 11 pp. 21–23, 4 figs. Baltimore, Md., 1947.

A method of using hexaethyl tetraphosphate, referred to as a vapo-diffusion method, has given satisfactory control of insects on greenhouse plants. The insecticide is projected through a venturi-type nozzle, with compressed air or its equivalent acting as propellant and an ordinary glass jar beneath the nozzle with a feed tube serving as a holder for the insecticide. A commercial preparation containing 9 per cent. tetraethyl phosphates with other organic phosphates and organic solvents and wetting agents was used in the tests reported. The addition of organic solvents gave the most satisfactory results for this method of application ; they appear to have desirable effects on the volume of vapour as well as on its distribution and stability. Most satisfactory results were obtained with fairly high pressures (100–150 lb. [per sq. in.]) ; in greenhouses too large to be treated from one position, the best results were obtained with one-nozzle applications from several positions. The nozzle is placed near the floor of the house so that the vapours rise beneath the plants or benches and gradually disperse throughout the atmosphere. Direct contact between the material coming from the nozzle and the plants should be avoided, as although most of it is dispersed as vapour, slide tests have shown droplets up to 20 ft. from the nozzle. Various dosages have been used and a standard one of $\frac{1}{4}$ lb. of the preparation per 1,000 sq. ft. of floor area has been adopted. Roof height is not considered as this dosage is adequate for greenhouses of average height. Houses 150 ft. long and 40–50 ft. wide can be treated from the middle of one end ; longer ones should be treated from both ends and if necessary from the middle. Wind currents outside must be taken into consideration in the selection of the point for release of the vapour.

At a pressure of 100–150 lb., the insecticide leaves the apparatus at the rate of about 1 U.S. pint every five minutes. In order to increase the amount of vapour and effect a more rapid saturation of the atmosphere, an equal amount of water may be used with the insecticide ; this is not essential but has proved advantageous in some cases. Greater dilution is not advisable, since excess moisture causes condensation on foliage. The use of the high air pressure

recommended provides rapid diffusion and vaporisation of the insecticide and also aids in its dispersion. Passing compressed air through the nozzle for a few minutes after the liquid has been dispersed further aids dispersal of the vapours. The most satisfactory equipment for the production of adequate pressure is a power-operated air compressor capable of producing pressures of 130–150 lb. continuously. Cylinders of compressed carbon dioxide or oxygen can be used, but are less satisfactory.

Plants treated successfully by this method included orchids, roses, carnations, gardenias and chrysanthemums. Some commercial greenhouses had six or more successive treatments with satisfactory control and favourable plant reaction. The insects controlled included the species generally infesting greenhouse plants. Heavy infestations of *Macrosiphum rosae*, L., and other Aphids were completely eradicated. Mealybugs were well controlled, the best results being obtained when the initial treatment was repeated in two or three days; a fairly heavy infestation of *Pseudococcus adonidum*, L. (*longispinus*, Targ.) on *Phalaenopsis* was practically eliminated by three fumigations. *Tetranychus telarius*, L., *T. bimaculatus*, Harvey, and other mites were successfully controlled when a second application was made against mites that hatched after the first treatment. There was no evidence of control of mite eggs. Other insects that were destroyed were certain caterpillars and moths, ants, Collembola, flies, mosquitos and cockroaches. Rats and mice were killed by the same treatment; operators without gasmasks and protective clothing should not enter greenhouses while the vapour is present.

CAPPS (H. W.). **Description of the Larva of *Keiferia peniculo* Heinrich, with a Key to the Larvae of related Species attacking Eggplant, Pepper, Potato and Tomato in the United States (Lepidoptera : Gelechiidae).**—*Ann. ent. Soc. Amer.* **39** no. 4 pp. 561–563, 9 figs., 1 ref. Columbus, Ohio, 1947.

In the course of a special survey in the vicinity of ports of entry in the United States, carried out by the Bureau of Entomology and Plant Quarantine in 1944–45, larvae of *Keiferia peniculo*, Heinrich [*cf. R.A.E.*, A **35** 300] were frequently found feeding on egg-plant [*Solanum melongena*]. The larva is described and a key is given to those of this species and *K. glochinella*, Zell., which also feeds on egg-plant, *Gnorimoschema pluesiosema*, Turner, on potato, *K. lycopersicella*, Busck, and *G. operculella*, Zell., on egg-plant, potato and tomato, and *G. gudmannella*, Wlsm., on pepper [*Capsicum*].

LANCHESTER (H. P.). **Larval Determination of six economic Species of *Limonius* (Coleoptera : Elateridae).**—*Ann. ent. Soc. Amer.* **39** no. 4 pp. 619–626, 5 figs., 6 refs. Columbus, Ohio, 1947.

Wireworms are primary pests of crops in the irrigated lands of the Pacific Northwest and locally throughout the United States. In the Pacific Northwest, the most important species belong to the genus *Limonius*. *L. canus*, Lec., and *L. californicus*, Mannh., are generally distributed throughout both the irrigated and the naturally moist areas of the semi-arid portions of the United States west of the Rocky Mountains, and *L. infuscatus*, Motsch., and *L. subauratus*, Lec., though less generally distributed, are of economic importance in limited areas and are frequently associated with the other species. Observations, field studies and laboratory experiments have shown that the larvae and adults of these species have specific differences in their response to field conditions and treatments.

To the east of the 105th meridian, *L. agonus*, Say, and *L. dubitans*, Lec., are of economic importance in certain areas and under certain conditions, and *L. ectypus*, Say, and *L. anceps*, Lec., are probably economic species. The close

relationship of the four eastern species to the western ones, as shown by the adults and the larval stages so far as they are known, make it probable that their activities and responses in the field are similar. Accurately determined larvae of *L. ectypus* and *L. anceps* were not available to the author, but the other two species are included with the four western ones in this paper, which contains a description of the larvae of *Limonius*, showing the characters by which those of the six species can be differentiated, and a key to them.

LINDGREN (D. L.) & DICKSON (R. C.). **Gastight Tents in *Citrus* Fumigation.**— *Calif. Citrogr.* **31** no. 11 pp. 418, 448–449, 2 figs., 3 refs. Los Angeles, Calif., 1946.

The authors report that two gastight tents, made of a fabric treated on both sides with a vinyl chloride resin [*cf. R.A.E.*, A **37** 185] were still gastight and showed little or no deterioration after having been used for six years in California for the fumigation of *Citrus* trees with hydrocyanic acid gas. When they were used with canvas tents in the commercially fumigated groves, one-third of the usual dosage applied in them generally gave a rather higher kill of red scale [*Aonidiella aurantii*, Mask.] than the full dosage in the canvas tents, and there was no more injury to the trees. In other tests, half dosage under gastight tents gave better control than the full dosage under canvas tents, particularly when there was some wind. Comparison of kills at different relative humidities showed that in general the kill of scale was slightly better with one-third dosage in a gastight tent than with the full dosage under canvas, regardless of humidity; there appeared to be little correlation between scale kill and relative humidity under either type of tent. Kills were lower on fruits touching the canvas tent than on those further in, but there was no difference in a gastight tent. At the end of one hour of exposure, about 8–10 times as much HCN remained under a gastight tent as under a canvas tent, and this relatively high concentration may be dangerous to the men handling the tents, especially in groves with large trees.

Although gastight tents have not yet reached the stage of development at which they can be used in the commercial fumigation of *Citrus* trees, it is considered that the results of the preliminary tests are promising [*cf.* **35** 227–228].

FULTON (R. A.) & NELSON (H. D.). **Removal of HCN from Gastight Tents.**— *Calif. Citrogr.* **32** no. 1 pp. 30–31, 2 figs., 2 refs. Los Angeles, Calif., 1946.

After the fumigation of *Citrus* trees with hydrocyanic acid gas under gastight tents, about two-thirds of the original dosage remains, and this has been recognised as a factor limiting their commercial use, because of the danger to the operators [*cf.* preceding abstract]. The elimination of this gas would not only remove the danger, but possibly also reduce protective stupefaction of Coccids by drift gas, since practically no leakage occurs during the exposure.

An experimental apparatus in which the air from the tent was drawn through soft wood shavings that were continuously sprayed with dilute sodium hydroxide reduced the concentration in proportion to the amount of air that passed through the absorbing unit, but in order to overcome the resistance of the air and reduce the concentration within one minute it was necessary to use an excessively large blower unit. Another apparatus, in which a large multivane blower was used to exhaust the mixture of air and gas into the air above the tents, was found to move a large amount of air with minimum power. The method of using it is described. It was found that when the blower was set to exhaust 3,500 or 4,500 cu. ft. per minute, the residual gas at the end of 50

seconds for trees of average size and shape (1,600–1,800 cu. ft.) was too little to be dangerous to the men. For larger trees it would be necessary to exhaust the gas for a longer period or to use a fan of greater capacity to ensure similar removal. While the gas was being withdrawn, none could be detected in the grove. The blower outlet velocity was approximately 2,400 ft. per minute when exhausting 4,500 cu. ft. per minute, and the air stream was carried above the trees in the grove. There was practically no danger of a toxic concentration near the ground, because the gas was mixed with a large volume of air during its removal from the tent.

EBELING (W.). **DDT Preparations to control certain Scale Insects on** *Citrus*. —*J. econ. Ent.* **40** no. 5 pp. 619–632, 2 figs., 7 refs. Menasha, Wis., 1947.

The following is based on the author's summary of this account of experiments on the use of emulsions of oil containing DDT against *Aonidiella aurantii*, Mask. [*cf. R.A.E.*, A **34** 79], carried out in 1945 in 14 orange and lemon orchards in seven counties in southern California. DDT was dissolved in light-medium spray oil and in kerosene at concentrations of 4·7 and 9·4 per cent. DDT by weight, 4 oz. blood albumin spreader per 100 U.S. gals. spray being used in nearly all the sprays. The 4·7 per cent. solution was prepared by dissolving the DDT in the oil after the latter had been heated to 60°C. [140°F.] and the 9·4 per cent. solution by adding 10 per cent. of a mutual solvent, usually Velsicol AR-60 or tetralin [tetrahydronaphthalene], to the oil before the DDT was added, unless the spray was prepared in the orchard and used immediately, when only 5 per cent. mutual solvent was added and the DDT was briefly stirred in the solution, after which the mixture was forced through the spray pumps for 1–2 minutes to dissolve the DDT. The reduced amount of mutual solvent proved to be satisfactory when the solution was used immediately and not subject to low night temperatures.

In determining the relative infestation of adult females of *A. aurantii* in plots sprayed with different concentrations of DDT in light-medium oil, corrections were made for original differences in scale population in the plots, and the infestations were expressed as percentages of that in a plot sprayed with 1·75 per cent. oil only. On the basis of population estimates made 4–14 months after treatment and averaging the results of five experiments, the percentage in plots sprayed with 1·75 per cent. oil containing 4·7 per cent. DDT was 65·3 and that in plots sprayed with oil containing 9·4 per cent. DDT was 40·3. However, oil with 9·4 per cent. DDT was inferior to oil alone in another experiment.

Spraying with 3 per cent. kerosene containing 4·7 per cent. DDT resulted in higher populations than spraying with oil alone in all but one experiment, but 3 per cent. kerosene with 9·4 per cent. DDT resulted in lower populations than oil alone in all but one. Two treatments of 3 per cent. kerosene containing DDT applied at an interval of about two months gave much better control of the scale than 1·67 or 1·75 per cent. light-medium spray oil. It was found that if the first spray was applied to wet the tree thoroughly, the second could be applied at a reduced rate and directed only against the outside of the tree, where decomposition of DDT takes place most rapidly. Aluminium stearate, which prevents or retards the penetration of kerosene into the foliage and bark of *Citrus* trees [*cf.* **35** 123], increased the effectiveness of sprays of DDT and kerosene when added to them at a concentration of 1 per cent. An experiment made with *A. citrina*, Coq., indicated that DDT is less effective against this scale than against *A. aurantii*.

A yellowing discoloration of a small proportion of the leaves of some trees sprayed with DDT was noticed in two of the 14 orchards ; the symptoms were somewhat different on orange and lemon. The leaves gradually regained their

normal colour and there was no greater leaf drop from affected trees than from trees on which the chlorosis was not found. Repeated chemical analyses have revealed no adverse effect of 3 per cent. kerosene containing DDT on fruit quality as indicated by concentration of sugar, acid and soluble solids, and this spray did not increase the incidence of water spot, which affects navel oranges after prolonged periods of rainy or wet weather, though regular oil sprays usually do so to a considerable extent [*cf.* **34** 79, etc.]. Di-2-ethylhexyl-phthalate containing 30 per cent. DDT by weight and used at 0·25 and 0·5 per cent., with the addition of 4 oz. blood-albumin spreader per 100 U.S. gals. spray, was inferior to 1·75 per cent. light-medium oil according to population estimates made 13 months after application, but it might be better if the dosage could be increased with safety to the tree or if repeated applications were made. When navel oranges picked 25–37 days after treatment were kept continuously wet for 1–3 days in chambers in which a condition simulating rain was artificially produced, no more water spot was found on them than on fruit from untreated trees or those sprayed with 3 per cent. kerosene containing DDT.

Easter (S. S.). **Control of Japanese Beetles at Second Army Posts.**—*J. econ. Ent.* **40** no. 5 pp. 632–634, 1 fig. Menasha, Wis., 1947.

Popillia japonica, Newm., is a serious pest in much of the Second Army area of the United States, which includes Ohio, Indiana, West Virginia, Virginia, Kentucky, Pennsylvania and Maryland. Injury by the larvae is common on grassed areas, and the adults cause serious damage to some ornamental plants and adversely affect the morale of personnel when they fly in large numbers.

Since 1940, spore dust of the milky disease, *Bacillus popilliae*, has been applied to 18 army posts with very satisfactory results. No turf damage was found after the disease was well established, which usually required about two years. Only the well-maintained grassed areas were treated, as these attract the females in large numbers for oviposition. Light egg deposition occurs on poor grass or weeds elsewhere on the post, and this provides a continual scattered population of larvae, the numbers of which are too low to cause any turf damage. However, the low population of adults produced concentrates on susceptible trees, which are common in the plantings at permanent army posts. Traps tend to attract still more beetles to the favoured plants, and are therefore not recommended and it is concluded that trees and shrubs favoured by the beetles require a protective spray for years after milky disease has become established and has stopped damage to turf by the larvae. In 1944, some protection to foliage was afforded by the use of a repellent lime spray, but it was not entirely satisfactory. In 1945, a spray of 2 lb. 50 per cent. wettable DDT per 100 U.S. gals. water, applied twice during the period of adult activity, gave promising results, and in 1946 the same spray had a residual effect for more than 30 days. In the course of aerial spraying for mosquito control with a spray of 20 per cent. DDT in oil, at the rate of 0·2 lb. DDT per acre, it was observed that the ground beneath a large lime tree was completely covered with dying beetles three hours after spraying, but the outer leaves of the trees were almost covered with feeding beetles six hours after spraying, indicating that there was no residual effect. This tree was evidently directly under the aeroplane and received the maximum dosage, and observations at other points where the beetles were abundant did not reveal comparable mortality.

A heavily infested field of sweet maize, in which as many as 30 beetles were found on a single ear, was sprayed with 2 lb. 50 per cent. wettable DDT per 100 U.S. gals. water. One trip was made across the field in mid-afternoon on 31st July, 1946, using the full drift of a slight breeze on one side and spraying into the breeze on the other at a pressure of 400 lb. per sq. in. By lifting the spray gun to an angle of 45°, an effective visible deposit was obtained for over

100 feet with the wind and for 50 feet into the wind. About 125 U.S. gals. spray was used on the two acres. An hour after spraying all high ears and those facing the direction of the spray were free of beetles, and on the following day practically no beetles were found feeding anywhere in the field, even in the area on which there was no visible deposit on the foliage. Dead and dying beetles were found in the axils of the leaves and all over the ground.

KULASH (W. M.). **Benzene Hexachloride, DDT, and Chlordane for Colorado Potato Beetle Control.**—*J. econ. Ent.* **40** no. 5 pp. 640–643, 5 refs. Menasha, Wis., 1947.

The results are given of experiments against *Leptinotarsa decemlineata*, Say, on potato, carried out in North Carolina in 1946. The treatments were applied on 8th June, when the plants were 12 ins. high, and on 8th July, and the rates of application per acre were 100 U.S. gals. for sprays and 25–30 lb. for dusts. Quantities given for spray ingredients are per 100 U.S. gals.

Dusts of 1 or 3 per cent. DDT and sprays of 1 lb. actual DDT as a wettable powder or 1–2 U.S. pints of emulsion concentrates containing 25 per cent. technical DDT gave good control of the larvae, but a concentrate in which the DDT had a high content of o,p'isomer was less effective, as was another concentrate when 1 U.S. quart polyethylene pentasulphide [*R.A.E.*, A **37** 183] was added to it. A spray of 2 lb. technical chlordane was about as effective as the better DDT sprays, and benzene hexachloride gave good immediate control, but did not prevent rapid reinfestation, whereas most of the DDT treatments were still effective after three days. It was used as a suspension of 2 lb. 50 per cent. wettable powder (6 per cent. γ isomer), as an emulsified solution at a concentration giving about the same concentration of active ingredient, and as a 5 per cent. dust (1 per cent. γ). A spray containing 12 U.S. pints of a solution of 0·6 gm. pyrethrins and 6 gm. piperonyl cyclohexenone per 100 cc. gave poor control.

None of these treatments caused any injury to the potato foliage, and neither cooked nor raw tubers had any odour or taste of insecticide one month after treatment.

KULASH (W. M.). **Benzene Hexachloride and Chlordane to control Cotton Boll Weevil.**—*J. econ. Ent.* **40** no. 5 pp. 644–650, 3 refs. Menasha, Wis., 1947.

In field tests carried out in North Carolina in 1946 with BHC (benzene hexachloride) in dusts against *Anthonomus grandis*, Boh., on cotton, two applications were made on 12th and 27th July of a dust containing 1 per cent. γ isomer and three on 3rd, 9th and 14th August of one containing 5 per cent. The weaker dust did not reduce the abundance of the weevils of the second generation, which were emerging at the time, but the other reduced the infestation considerably, though it did not seem to have any marked residual effect 3–4 days after application and scorched the foliage if applied too heavily [*cf. R.A.E.*, A **37** 195]. This dust caused rapid mortality of adults of Carabids, Elaterids and the Cicindelid, *Megacephala* (*Tetracha*) *carolina*, L., which were numerous on the plots, and of wasps, bees and grasshoppers. There was a sudden increase in the number of weevils after treatments were stopped, indicating the value of continued dusting to prevent the injury to bolls and squares caused by heavy late infestations and to reduce the numbers of weevils entering hibernation.

In the laboratory, BHC dusts and chlordane dusts and sprays were tested by two methods. For the first, untreated weevils were put in a jar containing the test material but prevented from coming into contact with it, and in the

second the dust or spray was applied to fresh sprigs of cotton foliage that were put in a jar with untreated weevils. Tests with BHC by the first method showed that the fresh dust was definitely toxic to the weevils without actual contact. Dusts containing 1, 2, 5 and 10 per cent. γ isomer showed equal knockdown and kill after two or three days, but the knockdown had been more rapid at the higher concentrations. Weevils exposed to BHC by the second method showed a quicker response to the various dust concentrations, but 72 hours after treatment, the kills with concentrations of 1, 2, 5 and 10 per cent. γ isomer were about equal and little different from those obtained by the first method. Exposure of the BHC dust to room air for three days caused a marked reduction in its effectiveness at all concentrations.

In tests by the first method, dusts containing 2 and 5 per cent. chlordane caused no more mortality than an inert dust eight hours after treatment but caused significantly higher knockdown and kill after 48 hours, with no significant difference between them. The same dusts resulted in higher and more rapid kill when applied to the foliage. The knockdown and kill of weevils put on foliage sprayed with 0·1, 0·2, 0·5 and 1 per cent. chlordane varied with the concentration of the spray. This variation was apparent eight hours after treatment, and 48 hours after treatment there was a significant difference in the number of weevils knocked down and killed by the three highest concentrations. Comparison of results showed that chlordane sprays were apparently more toxic to *A. grandis* than chlordane dusts but did not produce mortality so rapidly, and that BHC dusts containing 2 and 5 per cent. γ isomer were more toxic than dusts containing 2 and 5 per cent. chlordane.

KULASH (W. M.). **DDT and Benzene Hexachloride for Potato Flea Beetle Control.**—*J. econ. Ent.* **40** no. 5 pp. 651–654, 5 refs. Menasha, Wis., 1947.

Irish potatoes growing in the Blue Ridge Mountains of North Carolina are subject to heavy attacks by *Epitrix cucumeris*, Harr., from the time that the plants show until the middle of July and by *E. hirtipennis*, Melsh., from the middle of July until late August or September. The Sequoia variety, which is well adapted to this area, is somewhat resistant to flea-beetle attack, but shows loss of vigour and yield in seasons of very heavy infestation. Feeding by the adults on the leaves reduces growth and production of tubers and may cause a large reduction in yield, and plants that are heavily attacked become more susceptible to attack by Jassids and subsequent tip-burn, which may cause premature drying of the foliage. Feeding by the larvae on the tubers early in the season is usually overcome by the growth of the tuber, but feeding after the tuber is half grown causes roughening of its surface. A dust containing 3 or 5 per cent. DDT gives practically complete protection when applied about 6–7 times at weekly intervals from the time that the plants are 3–4 inches high [*cf. R.A.E.*, A **34** 337], and in 1946 investigations were made to determine whether similar control could be obtained by using lighter applications of some of the new forms of DDT.

Emulsion concentrates, mostly containing 25 per cent. technical DDT, used at 1 or 2 pints per 100 gals., were compared with a spray of 11 gm. of a benzene-hexachloride wettable powder (6 per cent. γ isomer) per U.S. gal. and a 3 per cent. DDT dust, in five applications between 13th June and 28th July. None of the treatments injured the plants. All reduced the numbers of flea-beetles by about 90 per cent. within half an hour of treatment, and the percentage reduction in numbers one day after treatment was about equal for all, but there was a gradual increase in flea-beetles in all plots during the next six days, and it appeared that the 3 per cent. dust was the only treatment that had any marked residual effect.

Allen (N.) & Pollard (H. N.). **Baits to control Green June Beetle Larvae in Tobacco-plant Beds.**—*J. econ. Ent.* **40** no. 5 pp. 655–660, 2 figs., 3 refs. Menasha, Wis., 1947.

In tests carried out in South Carolina in 1941 on the use of baits for the control of larvae of *Cotinis nitida*, L., which damage tobacco roots by their burrowing, the bait of paris green and wheat bran (1 : 25) used in plant beds was much more effective than supposedly identical baits used in the greenhouse [*cf. R.A.E.*, A **31** 255]. Investigations showed that the bran in this bait probably contained middlings, and tests were therefore made with various wheat products. Paris green mixed with wheat middlings, wheat shorts, equal parts of bran and middlings or equal parts of bran and shorts killed approximately twice as many larvae as paris green with bran, and in tests with products of different particle sizes, higher mortalities were obtained with small or medium-sized particles than with large ones of the same material, but the larvae evidently preferred middlings, shorts and even whole-wheat flour to wheat bran, even when these did not mix well with the water used to moisten the baits. The addition of syrup to the wheat middlings did not increase the effectiveness of the bait.

Small field-plot experiments carried out in 1941–45 showed that in general wheat middlings, wheat shorts and wheat products sold as pig food were more effective carriers for insecticides than wheat bran ; that wheat shorts, even though giving good mortality of larvae, made a poor mixture ; that the most effective of the insecticides tested were barium, sodium and potassium fluosilicates ; and that sodium arsenite, cubé, pyrethrum, basic copper arsenate and cryolite were either avoided by the larvae or were not sufficiently toxic to give satisfactory control. A bait of paris green, maize meal and syrup, developed in the greenhouse, was not entirely satisfactory in plant beds because it became dry and crumbly, and therefore unattractive, when put under plant-bed covers during warm, dry weather.

Additional experiments were made on farms with baits of paris green with maize meal and syrup, wheat bran, or wheat middlings and barium, sodium or potassium fluosilicate with wheat middlings, applied for the control of the larvae in beds of growing plants. Frequent counts of their burrows showed that the larvae were being killed, the best results being obtained with the fluosilicate baits. Applying bait to the burrows or to the burrowed areas was about as effective as broadcasting it and took less material. The paris-green baits were not only less effective than the fluosilicate baits, but, unless carefully applied under favourable conditions, seriously damaged plants, especially if broadcast over small ones. The bait of barium fluosilicate and wheat middlings was also tested on infested plant-bed sites during autumn. One application broadcast over severely infested ground at the rate of 20 lb. (wet weight) per 100 square yards gave excellent control, and the treated areas subsequently produced a good stand of healthy plants. Repeated tests showed that the most effective bait must be exposed to the larvae for at least a week for maximum efficiency, and that the effect of rain on a bait is of less importance than is generally supposed ; although heavy rain will wash a bait away, light rain improves the results obtained, probably because it increases the burrowing activities of the larvae.

Douglas (W. A.). **The Effect of Husk Extension and Tightness on Earworm Damage to Corn.**—*J. econ. Ent.* **40** no. 5 pp. 661–664. Menasha, Wis., 1947.

The author describes various methods used to study the effect of husk extension on the resistance of maize ears to attack by *Heliothis armigera*, Hb. [*cf. R.A.E.*, A **28** 22 ; **29** 367], and gives the results obtained with certain

inbred, hybrid and open pollinated varieties of maize in Mississippi since 1943. The following is based on his discussion. In these studies, somewhat more earworm damage was done to ears having no husk protection, but a husk extension of 2–3 inches afforded as much protection as did one of 5–6 inches, and most of the ears of all varieties but one had husk extensions of two inches or more. Earworm damage differed greatly among varieties and hybrids with approximately the same husk extension and tightness. The positive tendency towards resistance in the variety La. 1030, as indicated by its low earworm damage and percentage of infested ears, apparently did not depend on extreme length and tightness of husk.

Estimated tightness of husk in the inbred lines was correlated with total length of husk and with husk extension beyond the tips of the ears. In these lines the average length of the ears remained about uniform in all husk lengths. This condition is probably characteristic of the particular lines used in the tests, as in the variety and hybrid studies the length and weight of ears was generally inversely proportional to the husk extension.

From the data obtained, it does not seem desirable to emphasise husk extension of more than two or three inches in breeding for protection from injury by *H. armigera*, but moderate husk extension and tightness seem desirable for protection from other insects such as *Calandra* (*Sitophilus*) *oryzae*, L., as well as from birds, diseases and weathering, in the development of satisfactory maize hybrids for the southern United States.

PATCH (L. H.). **Manual Infestation of Dent Corn to study Resistance to European Corn Borer.**—*J. econ. Ent.* **40** no. 5 pp. 667–671, 3 refs. Menasha, Wis., 1947.

In order to determine the resistance or susceptibility of different strains of maize to infestation by *Pyrausta nubilalis*, Hb., or the effects of different numbers of larvae per plant on yield and stalk breakage, heavier infestations than those occurring naturally in the United States are usually required. These can be produced by obtaining egg masses in quantity from moths reared in the laboratory and pinning small disks of waxed paper, each bearing an egg-mass, on the plants just before the eggs hatch [*cf. R.A.E.*, A **21** 242]. For the most efficient use of such egg-masses, it is necessary to know the number to use and the conditions under which to use them to obtain different levels of infestation, and experiments were therefore carried out to find the number required at different stages of plant growth and for different degrees of soil fertility.

The following is based on the author's discussion. The addition of six and 12 instead of three egg-masses per plant gave increases in borer population that were variable but not proportional. In 1940, when the eggs hatched 20–31 days before silking and natural infestation averaged 2·18 larvae per plant, three additional masses (of about 20 eggs each) resulted in an average total of 6·5 borers per plant, six increased the latter average by only 19·5 per cent., and 12 increased it by 36·5 per cent. In 1942, when the eggs hatched 16–35 days before silking and natural infestation averaged less than 1 borer per plant, three additional egg-masses resulted in an average of 3·03 borers per plant, and six and 12 increased this average by 23·7 and 47·7 per cent. In 1941, when the eggs hatched 18–35 days before silking and natural infestation was also less than one, the addition of three egg-masses resulted in 1·6 borers per plant, and six and 12 increased this average by 50·5 and 105 per cent. Natural infestation on plants grown in 1929–32 in ground on which no fertiliser was used and in ground receiving one and two applications of fertiliser averaged 1·68, 2·33 and 2·78 larvae, respectively, and the addition of 1–5 egg-masses resulted in total populations averaging 5·68, 7·55 and 8·85. The results of these and

other experiments show that more borers may result from the addition of three egg-masses per plant when the growing conditions of the maize are favourable to larval establishment than from more than three when conditions are unfavourable, and in an experiment carried out in 1945 on several exceptionally thrifty plantings, no material increase in the number of borers was obtained by augmenting with 12 or 24 egg-masses per plant ; an average of 1·03 borers per plant was found where natural oviposition amounted to 1·7 egg-masses per plant, and 1·1 when an average of 18 additional masses was put on each plant between 30th June and 2nd July. A total of 5·86 ins. of rain fell between 27th April and 27th May and 7·74 ins. in June, and the maize plants grown under these conditions possibly did not provide the nutriments required by the larvae for establishment.

It was also found that the degree of plant maturity at the time of infestation affected survival of the larvae. Natural oviposition augmented with three egg-masses per plant when the plants showed fresh silks resulted in 5·1 times as many borers in 1941 and in 3·6 times as many in 1942 as when the eggs were put on the plants 24–40 days before silking, and adding 12 egg-masses per plant 6–7 days before silking in 1941 and 4–8 days before silking in 1942 resulted in only about as many borers as three egg-masses when the plants showed fresh silks. The gain in borer population by infesting each plant with additional eggs at three different times during the season was not much more than that obtained by adding all the egg-masses at once.

WENE (G. P.). **The Fog Aerosol Machine to control Vegetable Insects.**—*J. econ. Ent.* **40** no. 5 pp. 675–679, 5 refs. Menasha, Wis., 1947.

The results are given of preliminary experiments in which the Todd thermal aerosol fog generator [*cf. R.A.E.*, A **35** 259] was used in the autumn of 1946 against insects attacking market-garden crops in the Lower Rio Grande Valley of Texas to determine whether insecticides applied as aerosols would give commercial control in the field, the distances for which the aerosols are effective and the factors limiting their effectiveness. Water or kerosene was the aerosol medium, and the generator was driven on a truck through the field at the speed used in applying sprays to row crops.

In the first experiment, cages containing adults of *Diabrotica balteata*, Lec., from tomato were set on the ground near tomato plants at distances of 20, 40 and 60 ft. from the line along which the machine was driven, and a mixture of 5 per cent. DDT and 0·03 per cent. pyrethrins in kerosene was applied as small, medium or large particles (10, 20 and 30 microns, respectively). The percentages of beetles killed at 20, 40 and 60 ft. were 94, 100 and 33 by the large particles, in spite of the fact that the aerosol was subjected to drift in a wind blowing at ten miles per hour, but the medium-sized particles were effective only for 20 ft., and the small ones not even for this. In the second test, medium-sized particles of a mixture of 7·5 lb. 50 per cent. wettable DDT in 10 U.S. gals. water were at least as effective against larvae of *Trichoplusia ni*, Hb., in cages on the ground near cabbage plants at distances of 25 and 50 ft. as large ones, giving 90 and 65 per cent. mortality as compared with 60 and 55 per cent. All surviving larvae pupated within 48 hours.

Large aerosol particles were used in all the remaining experiments. Tests against *Aphis gossypii*, Glov., on squash gave erratic results, but aerosols of hexaethyl tetraphosphate in water and pyrethrum extract or DDT in kerosene, released under a 20 ft. lateral hood with an open end, gave effective control for the distance covered by the hood, though not beyond it. Aerosols of wettable DDT or piperonyl cyclohexenone in water or a DDD (Rothane) emulsion concentrate in kerosene were of little value, even when the hood was used. Aerosols of pyrethrum extract, DDT, DDD or piperonyl cyclohexenone

all gave excellent control of *Halticus bracteatus*, Say, on tomato, the last three of these even when applied against the wind under the hood, and also gave some control of *Lygus*, leafhoppers and *D. balteata*.

The wind often tended to lift the aerosol above the ground at about ten feet or less from the machine, but confining the fog under the hood increased its distance of effectiveness and appeared to be necessary on windy days. The effective distance of aerosol drift appeared to depend to some extent on the type of insecticide used, but the large aerosol particles were the most effective. The kerosene used as an aerosol medium did not injure the leaves of tomato, squash or cabbage.

LINDGREN (D. L.) & GERHARDT (P. D.). **The Response of California Red Scale to Fumigation with Ethylene Dibromide and Ethylene Dibromide-HCN.**—*J. econ. Ent.* **40** no. 5 pp. 680–682, 7 refs. Menasha, Wis., 1947.

In a search for new fumigants with which to control scale insects on *Citrus* in California, ethylene dibromide was compared with hydrocyanic acid gas against *Aonidiella aurantii*, Mask. Unless otherwise stated, the insects were mature females treated just before the production of young. Grapefruits were infested with resistant and non-resistant strains of *A. aurantii* [*cf. R.A.E.*, A **34** 302, etc.] and fumigated at a temperature of 75°F. The ethylene dibromide was either volatilised by setting a fan to blow over an absorbent material on which it had been applied, vaporised by means of a hot plate or vaporised in a flask and drawn into the fumigation chamber, and the results indicated that the three methods were equally effective. Tests with all stages of both strains showed practically no differences in kill between stages and strains with ethylene dibromide, whereas with HCN the differences between strains and between age groups of the resistant strain were considerable. Although practically all resistant and non-resistant adult females were killed by exposure to a dose of 15·5 mg. ethylene dibromide per litre for 45 minutes, they survived and produced living young for 4–6 days after treatment.

Since HCN is very toxic to the young scales, it appeared possible that all stages could be killed with a mixture of relatively low dosages of the two fumigants, but it was evident from the results of tests on adults that ethylene dibromide had very little or no effect in the mixture, even when used at high concentrations. Dosages of 15·5 mg. ethylene dibromide per litre alone, 0·1 mg. HCN per litre alone and these two concentrations together killed 99·5, 76 and 70 per cent. of the non-resistant scales, and 99·8, 28 and 35 per cent. of the resistant strain, respectively. To determine whether the HCN had some stupefying effect, females were exposed to a low concentration of HCN for five minutes and then to 7·7 or 15·5 mg. ethylene dibromide per litre for 45 minutes. The results showed that these were much more difficult to kill than others that had not received the conditioning treatment.

NEWELL (I. M.). **Quantitative Methods in biological and Control Studies of Orchard Mites.**—*J. econ. Ent.* **40** no. 5 pp. 683–689, 4 figs., 3 refs. Menasha, Wis., 1947.

One of the principal obstacles to studies of populations of orchard mites is the problem of making an accurate determination of the density of the population. The author describes a method developed for use with *Tetranychus pacificus*, McG., on apple in Washington that involves selecting leaf samples, removing mites and eggs by shaking in a soap solution, reducing the residue by screening, removing a known fraction of the sample under constant agitation and counting the mites and eggs in this fraction. He gives characters by which living and dead eggs and the different active stages of the mite can be distinguished.

Since determining the total population density just before and a few days after treatment is shown to be inadequate for obtaining a general idea of the mortality sustained by a given population of *T. pacificus* after the application of sprays or dusts, owing to the difficulty of distinguishing between egg mortality and mite mortality, the author describes a procedure, based on life-history studies, for making the distinction. This involves collecting one sample immediately before spraying and expressing the population density in terms of mites and eggs per leaf, keeping an accurate temperature record, and taking a second sample after a length of time equal to the incubation period at the prevailing temperature, segregating the stages into eggs ; larvae and protonymphs ; and deutonymphs and adults. The time interval between the taking of the first and second samples permits the development of the post-mortem changes that are necessary to distinguish living from dead mites and makes it possible to determine egg mortality by observing the proportion of eggs that hatch, since larvae and protonymphs of the second sample were eggs when the first sample was taken. The reductions in population are determined from formulae that are given.

Brower (A. E.). **The Balsam Woolly Aphid in Maine.**—*J. econ. Ent.* **40** no. 5 pp. 689–694, 2 figs., 7 refs. Menasha, Wis., 1947.

Chermes (*Adelges*) *piceae*, Ratz., is the most destructive insect pest of balsam fir [*Abies balsamea*] in Maine and caused heavy losses in 1930–34. Observations over 16 years have shown that the Aphid is distributed over the southern half of the State and that severity of infestation is associated with low-lying, poorly drained or water-logged soils and is greatest in low-lying areas of Washington and Hancock Counties. The infestation is endemic in sites unfavourable for the growth of the fir and spreads from them to injured or unthrifty trees. The localities in which it is heaviest are indicated by associated plants, some of which are listed.

There are two distinct types of injury [*cf. R.A.E.*, A **21** 283]. The first is caused by Aphids that settle on the distal portions of the branches and feed on the bases of the buds and on the nodes and needles, so that growth is more or less completely stopped, and the second by those that spread upwards on the trunk from below the snow line, where they are able to survive subzero temperatures. Trunk attack, which can occur on trees of any age, may render much of the wood unfit for timber, owing to the formation of thick-walled vessels and abnormal deposition of lignin. In experiments, young Aphids from the trunk attacked buds, and *vice versa*. Tip injury occurs chiefly on young trees and may kill the part affected or cause gall-like swellings on it. Very young trees may be quickly killed by the infestation, and others die as a result of suppression or the attacks of secondary insects.

No alates or males of *C. piceae* have been found in Maine, and *A. balsamea* is the only native food-plant, though a large example of *A. nordmanniana* was apparently killed by a heavy stem attack in 1934. There are two complete generations in the year and probably a partial third, and the winter is passed by sedentary individuals in the first instar. Observations on the life-history are recorded [*cf.* **22** 396]. The egg stage lasts 7–14 days and the mobile Aphids in the first instar settle after about six days. Both eggs and mobile Aphids are distributed by wind. Some of the young remain under the wax produced by the parent, and the clusters contain increasing numbers of individuals. The presence of a few of these on the trunk is of little importance, but when there are several per square inch, the infestation increases rapidly and kills the tree in a few years unless it is checked by climatic conditions. Annual records showed that only 16·7 per cent. of heavily infested trees survived, and 30·3 per cent. of trees bearing medium infestations. Trees that survive heavy infestations

are resistant to further attack by *Chermes*, but are often killed by bark-beetles and Longicorns. Aphids above the snow line are killed by low winter temperatures, but predators afford little control. Syrphid larvae occasionally attack the Aphids, and in August 1946, larvae of the Lycaenid, *Feniseca tarquinius*, F., were observed to be feeding on them. No parasites have been found. Sprays that have proved effective comprise lime-sulphur at dormant strengths (1 : 8 and 1 : 12), oil emulsions and nicotine sulphate (1 : 400) ; they are best applied against the mobile first-instar Aphids, which are only scantily covered with wax.

Anderson (R. F.). **The Saratoga Spittlebug.**—*J. econ. Ent.* **40** no. 5 pp. 695–701, 3 figs., 10 refs. Menasha, Wis., 1947.

The author gives further results of investigations on *Aphrophora saratogensis*, Fitch, attacking *Pinus banksiana* and *P. resinosa* in the Lake States [*cf. R.A.E.*, A **36** 220] and describes all stages of this Cercopid. The eggs were commonly found in the sheaths of the current season's needles of both trees and under the bud scales of several species of hardwoods and *P. resinosa* ; the buds of *P. banksiana* were too resinous to be attractive to ovipositing females. The nymphs feed on herbaceous and low-growing woody plants near the trees. In 1944, the first were found on 17th May, when the leaf buds were expanding on sweet fern [*Comptonia peregrina*], one of the preferred food-plants [*cf.* **33** 107], and blueberry, but in 1945 development occurred two weeks later. In 1944, nymphs were found feeding on upwards of 25 species of plants, which are listed, in addition to *C. peregrina*, and in 1946 small numbers were observed on ten additional species. They apparently migrated from one plant to another, feeding near the root collars, and were usually concealed under the surface litter. Night temperatures below freezing point for seven hours caused no mortality of those in such protected positions though they killed 80 per cent. of unprotected nymphs, so that very severe weather during the period of nymphal development would be required to reduce the population substantially.

There seemed to be few natural enemies ; a few mummified nymphs suggested fungous activity, parasite larvae were removed from three of 220 adults dissected and one spider was observed feeding on an adult. The observations indicated that control might be obtained by growing denser plantations of pine or encouraging the growth of desirable hardwoods to form a mixed stand in order to eliminate or reduce the proportion of nymphal food-plants [*cf.* **33** 108]. Destruction of the nymphal food-plants with weed-killers is another possible method of control, but it has not yet been tested.

Boyce (A. M.) & Fawcett (H. S.). **A parasitic *Aspergillus* on Mealybugs.**—*J. econ. Ent.* **40** no. 5 pp. 702–705, 10 refs. Menasha, Wis., 1947.

During a period of relatively high humidity in the spring of 1926, mealybugs that were being propagated on potato sprouts in insectaries in southern California as laboratory hosts for *Cryptolaemus montrouzieri*, Muls., died in large numbers. A fungus later identified as belonging to the group of *Aspergillus flavus-oryzae* was observed on the dead insects. Mortality ceased with the advent of drier atmospheric conditions, but as it recurred in the following spring, investigations were begun early in 1928.

Pure cultures of the fungus were obtained on poured plates of glucose potato agar from inoculum from the mealybugs, and grew well at temperatures of 17–32°C. [62·6-89·6°F.]. The perfect stage was not observed. To determine whether the fungus was truly parasitic, examples of *Pseudococcus gahani*, Green, and *Phenacoccus gossypii*, Tns. & Ckll., were rolled over several times in pure cultures, while control insects were put on sterile agar or rolled in cultures

of another fungus of the same group that grew at much the same rate and with the same degree of sporulation as the parasitic form. This was frequently present with the parasitic fungus, often on the same dead mealybug, but throve on dead parts of the potato plants and appeared to develop on the insects only after they died, giving negative results in several series of tests to determine whether it could kill them. All cultures were maintained at a fairly constant temperature of 32°C. and a relatively high humidity and examined daily. At this temperature, 95–100 per cent. of the mealybugs died within 48 hours of inoculation with the test fungus, whereas practically all the controls were normal. Most of the insects died before the fungus sporulated, but a few living mealybugs had several sporophores on their bodies ; they died within 12 hours, and many sporophores were evident very soon after. The appearance of the infected mealybugs is described. The insects used were in various stages of development, and there was no indication that younger ones were more susceptible than older ones or that one species was more readily killed than the other.

In experiments in which cultures containing 40–75 mealybugs were kept at constant temperatures, the lowest temperature at which the fungus killed the mealybugs was 21°C. [69·8°F.] at which death took place in 72 hours. The time required to cause death decreased at successively higher temperatures, until only 36 hours were necessary at 29°C. [82·4°F.].

Early in March 1946, evidence of the parasitic fungus was found in insectaries in Orange and Los Angeles counties under conditions of high relative humidity. It was readily controlled by lowering the humidity, but 95 per cent. of the mealybugs were killed in some of the rooms. Fungicidal treatment did not seem to be practicable ; very careful irrigation and good ventilation appear to be the most important methods of control.

Comparison of cultures of the parasitic fungus with one that attacked *Pseudococcus boninsis*, Kuw. (*calceolariae*, auct.) on sugar-cane in Hawaii and was described as *A. parasiticus* in 1912 indicated that the Californian form differed somewhat from it, but was probably not a distinct species. Records of parasitism of mealybugs and other insects in various parts of the world by similar strains of *Aspergillus* are briefly reviewed.

BERRY (P. A.). **Investigations on the White-fringed Beetle Group in South America.**—*J. econ. Ent.* **40** no. 5 pp. 705–709, 7 refs. Menasha, Wis., 1947.

A review is given of the results of investigations on species of *Graphognathus* in South America, carried out at intervals since September 1938 with a view to finding insects that could be used to control *G. peregrinus*, Buchanan, and the races of *G. leucoloma*, Boh., in the United States [*cf. R.A.E.*, A **37** 36] ; the following is substantially the author's summary of it. Species of *Graphognathus* are distributed over a large area of South America, the known range being from Ancud and Castro, Chile, and Rio Negro, Argentina, in the south, to Lima, Peru, and Santa Maria, Rio Grande do Sul, Brazil, in the north. Populations of these beetles are relatively low throughout the agricultural areas, but many infestations dense enough to cause serious damage to various cultivated crops have been found. The principal crops on which damage was observed were beans in Chile, lucerne in Argentina and strawberries in Uruguay ; other damage was confined chiefly to garden crops and other small plants. Larval populations are generally more dense in sandy loam soils than in the heavy clay types. They are light in practically all types of cultivated crops, and dense infestations have been found only on lucerne and clover of two, three or more years' standing.

The seasonal history appears to vary according to climatic conditions, the life-cycle lasting two years in the southern part of the range and only one in the north. No insects were found attacking *Graphognathus* in South America; two species of birds, *Milvago chimango chimango* and *Belonopterus chilensis chilensis*, feed on the larvae, but they probably have little effect in reducing the population as they can reach them only during cultivation of the soil.

Sun (Yun-Pei) & Shepard (H. H.). **Methods of calculating and correcting the Mortality of Insects.**—*J. econ. Ent.* **40** no. 5 pp. 710–715, 5 refs. Menasha, Wis., 1947.

The following is almost entirely based on the authors' summary. Estimates of the percentage mortality of an insect caused by an insecticide may vary considerably with the method used to determine and express it. They are affected by the criterion of death selected, the length of time between treatment and counts of dead insects, and, in the case of insects that reproduce rapidly, by the rate of reproduction. The use of Abbott's formula to allow for natural mortality [*R.A.E.*, A **13** 331] is common, but no serious consideration has been given to allowance for an increase in population, though this is even more important for insects of which numerous young individuals are continually added to the population. The differences in results obtained by making mortality counts in several ways are determined from experiments with *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.), and a general equation is derived from the populations that would theoretically have been present if the plants had not been treated, by which results can be corrected for increases or decreases in population. The corrected percentage reduction in population in treated plots is given by the formula $100\ (Pt \pm Pc) \div (100 \pm Pc)$, where Pt is the percentage of apparent mortality in treated plots, based on numbers of living insects, and Pc is the percentage change of population in the untreated one; the sign will be positive when the population in the untreated plot has increased and negative when it has decreased. This is similar to Abbott's formula, which was based on the percentage of living insects, and this strongly supports the validity of the latter even where there are increases in populations in untreated plots.

It was found that when the untreated population was increasing, the apparent mortality was generally smaller than when the results were calculated by the authors' equation, owing to the number of young born after treatment that survived until mortality was determined; the differences were greater at low than at high percentages. Moreover, the percentage reduction of population calculated on the basis of the population of the untreated plot was about the same as that obtained by the suggested equation only when the original population of insects was uniformly distributed. It is shown that a population that is not uniformly distributed gives misleading results even though the percentage of change in population remains the same, and that the suggested equation eliminates large errors from this source.

Carruth (L. A.) & Hervey (G. E. R.). **DDT and other Insecticides for Squash Borer Control.**—*J. econ. Ent.* **40** no. 5 pp. 716–721, 3 figs., 6 refs. Menasha, Wis., 1947.

The following is based on the authors' summary. Tests made at Geneva, New York, in 1944 and 1946 confirm published reports of the effectiveness of DDT for controlling *Melittia cucurbitae*, Harr. (*satyriniformis*, Hb.), and of possible differences between varieties of squash and pumpkin in susceptibility to DDT injury [*cf. R.A.E.*, A **34** 337, 338]. Tests in 1946 showed that much

of the observed foliage injury and reduction in yield produced by DDT dusts was associated with the temperature at which the various grades of DDT crystallised. Three per cent. dusts prepared from DDT for which this was 90°C. [194°F.] (similar to that of technical DDT) were more injurious than similar dusts of DDT for which it was 103–105°C. [217·4–221°F.]. Nine varieties of squash and pumpkin, representing three botanical species, were used in 1946. Squash of the Hubbard type (*Cucurbita maxima*) was apparently not injured by 3 per cent. dusts made from either grade, although moderate yield reduction had occurred in plots of Blue Hubbard dusted with 2 per cent. technical DDT in 1944. The most severe foliage injury and yield reduction occurred on squash and pumpkin varieties of *C. pepo* after treatment with 3 per cent. DDT having a crystallising point of 90°C. ; Connecticut Field Pumpkin was the only tested variety of this species that showed no such adverse effect on yield. Almost no foliage injury or yield reduction occurred when these varieties were treated with 3 per cent. DDT having a crystallising point of 103–105°C. Butternut squash (*C. moschata*) responded similarly to most tested varieties of *C. pepo* as regards foliage injury and yield reduction. In 1946 no phytotoxic effects were observed on plants of any variety that were dusted with 1 per cent. rotenone or 40 per cent. Ryanex (from ground stems of *Ryania speciosa* [*cf.* **34** 137]). Plants dusted with 3 per cent. di(methoxyphenyl)trichlorethane [methoxy-DDT] developed rugose foliage symptoms, but these usually disappeared after treatment ceased and apparently affected the yield of only two of the nine varieties tested.

Extremely low infestations of *M. cucurbitae* on Dickinson pumpkin (a variety of *C. pepo*) and Butternut squash indicated a possible varietal resistance to this insect.

Siegler (E. H.) & Hall (S. A.). **Hexaethyl Tetraphosphate as an Insecticide.**—*J. econ. Ent.* **40** no. 5 pp. 722–724, 8 refs. Menasha, Wis., 1947.

In tests with aqueous solutions of HETP (hexaethyl tetraphosphate) against larvae of *Cydia* (*Carpocapsa*) *pomonella*, L., by the apple-plug method [*cf.* *R.A.E.*, A **23** 174], none of the plugs was "stung" and the percentages infested were, respectively, 0 and 50 for newly made solutions containing 1 or 0·25 lb. per 100 U.S. gals., and 72 and 86 for a solution of 1 lb. per 100 U.S. gals. when the plugs were infested three days after spraying and when the solution used had been standing for 12 days. As HETP hydrolyses to comparatively non-toxic compounds in water solution, spray deposits are not sufficiently effective for the practical control of *C. pomonella*. There was no significant difference in the insecticidal potencies of HETP prepared by two different patented methods.

HETP was tested against Aphids by spraying shoots of apple, chrysanthemum and *Helianthus* infested with *Aphis pomi*, Deg., *Macrosiphoniella sanborni*, Gill., and *Macrosiphum ambrosiae*, Thos., respectively, and by a leaf-disk technique [*cf.* **36** 343] in which the test insects were *Brevicoryne brassicae*, L., and *Myzus persicae*, Sulz., on kale and *Aphis gossypii*, Glov., *M. persicae* and *Macrosiphum solanifolii*, Ashm., on squash. On infested shoots, 0·1 and 0·05 per cent. HETP were compared with 0·05 per cent. nicotine (from nicotine sulphate), 0·05 per cent. Dreft being added to each solution as a wetting agent. The results showed that freshly-prepared solutions of HETP were about as effective as nicotine and highly toxic to all the species tested, whereas solutions that stood for one day before use lost much of their effectiveness. In the leaf-disk tests, in which the infested disks were immersed for three seconds, 0·1 per cent. HETP killed all the Aphids on both plants, while 0·05 and 0·025 per cent. gave complete mortality on squash but not on kale ; 0·05 per cent.

Dreft was again added to each solution. In leaf-disk tests against *Tetranychus bimaculatus*, Harvey, on lima bean, freshly prepared solutions containing 0·05 or 0·1 per cent. HETP alone or 0·025, 0·05 or 0·1 per cent. with 0·05 per cent. Dreft, were very effective against both nymphs and adults. The solutions containing Dreft lost their effectiveness after ageing for one day.

GREENWOOD (D. E.). **Benzene Hexachloride and Wireworm Control.**—*J. econ. Ent.* **40** no. 5 pp. 724–727. Menasha, Wis., 1947.

The results are given of investigations on the use of BHC (crude benzene hexachloride containing 10 per cent. γ isomer) to control wireworms attacking potato in Connecticut, carried out chiefly to determine the concentration most effective under field conditions, the methods most suitable for practical application and the relationship of the amount applied or the method of application to the taste of tubers grown in treated soils. The soils on which the tests were made were fine sandy loam (pH 5) and the treatments were applied during the first week of May.

The fields selected for broadcast treatment were ploughed and disk-harrowed, after which dusts of BHC in pyrophyllite were applied with a grain drill and the plots were disk-harrowed once each way to mix the soil and insecticide to a depth of 5–6 inches. Dusts containing 1, 3 and 5 per cent. BHC applied at 65, 65 and 100 lb. per acre, respectively, reduced the percentages of injured potatoes from 78·6 to 39·4, 9·3 and 12, the last two results being commercially satisfactory. An application of 2·5 lb. BHC per acre in 250 lb. dust resulted in commercially clean potatoes, but was not better than 2 lb. applied in 65 lb. dust.

In row treatments, the rows were opened by a planter with the covering disks removed and dusts containing 1 or 5 per cent. BHC were applied with a hand duster ; the seed potatoes were planted and the rows covered by hand. Applications of 1·32 lb. BHC or more per acre gave very good commercial control, and applications of 0·33 and 0·66 lb. per acre, although much less effective in the very heavily infested field in which they were tested, reduced the injury considerably and might be expected to give commercial control elsewhere. Row treatments seemed to be more effective than broadcast treatments, but apparently involve greater risk of tainting the tubers. Dusting the seed potatoes with 50 per cent. wettable concentrate or dipping them in a water suspension of this did not give commercial control, although the BHC caused high kills of wireworms. Many of the seed potatoes were entirely free from wireworm feeding ten days after planting, indicating that there might be a slight repellent action. The dusted potatoes were slightly delayed in development during the first month of growth, but this effect soon disappeared, and the final yields were not affected. When baits of wheat containing 0·1 per cent. benzene hexachloride or 0·2 per cent. DDT were put beside untreated seed potatoes or seed potatoes dusted with lead arsenate to force the larvae to feed on the baits, the percentages of tubers injured was reduced from over 70 to about 34 in both cases by BHC and to 54 and 63 per cent. by DDT in the presence and absence of lead arsenate. Many larvae fed on the BHC, and this method of control may prove practical and effective against other insects, though it is not sufficiently so against wireworms.

Preliminary reports indicated that BHC applied in the row at 1·5 lb. per acre or broadcast at 2·5 lb. per acre did not contaminate the tubers. Broadcast applications of 7·5 lb. per acre imparted a slight taste to potatoes that were boiled in their skins but did not affect potatoes that were baked or boiled and peeled.

Pepper (B. B.), Wilson (C. A.) & Campbell (J. C.). **Benzene Hexachloride and other Compounds for Control of Wireworms infesting Potatoes.**—*J. econ. Ent.* **40** no. 5 pp. 727–730. Menasha, Wis., 1947.

In experiments against wireworms in New Jersey, dusts (of talc or pyrophyllite) containing 1 per cent. DDT or DDD (Rhothane) or enough BHC (benzene hexachloride) to give 1 per cent. γ benzene hexachloride were broadcast on the soil surface in April and immediately disked and harrowed into the top soil, after which potatoes were planted. Periodical examination throughout the season showed that the percentages by which wireworm injury were reduced were 90–100 for BHC dusts at rates of 2, 3, 5 or 10 lb. γ isomer per acre, and 93·6 for DDT and 80 for DDD, both at 25 lb. per acre. When BHC dust was broadcast at 1·6 lb. γ isomer per acre in November 1945 and potatoes were planted in April 1946, records at harvest showed 98·7 per cent. reduction in injury by wireworms. No plant injury resulted from any of the treatments except BHC at 10 lb. γ isomer per acre, which apparently caused slight retardation of germination. The plants treated with BHC remained green for considerably longer than untreated ones, and damage by the potato leafhopper [*Empoasca fabae*, Harr.] was much reduced, suggesting that some substance toxic to the insect was taken up by the plants.

Tubers from plants of which the foliage had been treated seven times between 11th June and 29th July with a spray containing 0·17 lb. γ BHC per 100 U.S. gals. water or eight times at weekly intervals from 8th June with a dust containing 0·45 per cent. γ BHC at the rate of 30–35 lb. per acre, were relatively free from wireworm damage, whereas severe injury occurred on untreated plots, and in a test in which an application of dust containing 0·75 per cent. against the potato Aphid [*Macrosiphum solanifolii*, Ashm.] was followed by rainfall, dead wireworms were numerous on the surface of the soil after treatment.

In laboratory tests, BHC at rates equivalent to 3, 5 and 10 lb. γ isomer per acre, mixed with soil in which cauliflowers were planted, gave complete mortality of wireworms that were kept in it from 13th or 31st May until 6th June.

Tests with baked and boiled potatoes indicated that most people could not detect any flavour due to treatment with BHC [*cf.* **37** 92].

Pepper (B. B.) & Wilson (C. A.). **Dichloro-diphenyl-dichloroethane compared with other Materials for Corn Earworm Control.**—*J. econ. Ent.* **40** no. 5 pp. 731–732. Menasha, Wis., 1947.

In a dusting experiment on maize in New Jersey in 1945, DDD gave better control of *Heliothis armigera*, Hb., and *Laphygma frugiperda*, S. & A., than other insecticides, and it was therefore tested against *H. armigera* on both early and late sweet maize in 1946. Dusts containing 3 per cent. DDD, DDT, di(p-methoxyphenyl)trichlorethane [methoxy-DDT] or toxaphene in talc or 20 per cent. lead arsenate in hydrated lime were applied on 3rd July to maize on which pollination was complete and the silks were dead, maize that had just been pollinated and maize that had not produced silks, and infestation records were made on 8th July. DDD gave more than 80 per cent. control in each field, DDT gave 70–80 per cent., toxaphene about 55–65 per cent., being about as effective as lead arsenate (40–65 per cent.) in two fields and more so in the third, and methoxy-DDT 45–60 per cent., being less effective than lead arsenate in two fields and more so in the third. DDD was less effective when it was applied by aeroplane than when it was applied with hand or power machines, the degree of control depending on the distribution of dust, direction of flight and width of swath.

In large-scale tests on late sweet maize, 3 per cent. DDD and 5 per cent. DDT gave 65·3 and 40 per cent. control of *H. armigera*, respectively.

HAMILTON (C. C.). **Azobenzene Dusts to control Red Spiders on some Greenhouse Plants.**—*J. econ. Ent.* **40** no. 5 pp. 733–735, 2 refs. Menasha, Wis., 1947.

When azobenzene is used as a fumigant against mites in greenhouses [*cf. R.A.E.*, A **35** 180], it must be maintained at a fairly uniform concentration for about six hours and the whole of a greenhouse must be treated. It can also be applied as a dust [*loc. cit.*], when it volatilises slowly, and if the dust can be put on the lower surface of the leaves where the mites occur or applied in fairly dense foliage that holds the fumes, it gives a kill approaching that obtained by fumigation. Azobenzene dusts have been used successfully in greenhouses that had no steam heating or were not airtight enough for fumigation and on outdoor plants. They have also been used as a local treatment on particular plants showing infestation.

In preliminary tests in New Jersey in 1942, 20 per cent. azobenzene dust gave good control of *Tetranychus bimaculatus*, Harvey, and in 1946, both this dust and one of 70 per cent. azobenzene and 30 per cent. Celite 209 [finely divided diatomaceous earth], applied at a rather lower rate, gave a high kill of the eggs and young of the mites and 60–70 per cent. kill of adults in a commercial rose greenhouse ; a second application a week later reduced infestation further, and when the house was fumigated with azobenzene about two weeks later, the kill on the dusted areas was much better than elsewhere. On young grafted magnolia plants, single applications of the 70 per cent. dust on 7th or 14th June or 14th July gave more than 80 per cent. kill of *T. bimaculatus*, and two or three applications gave more than 98 per cent. mortality of all stages, with no injury to the plants but slight scorching where the dust was applied very heavily. The same dust gave excellent control of all stages of *T. bimaculatus* on chrysanthemum in July with no injury to the plants, and a 50 per cent. dust gave an average kill of 95 per cent. of young and adults of *Hemitarsonemus latus*, Banks, on chrysanthemums in October, later examinations showing no increase in the infestation, so that the eggs must also have been killed. Hydrangeas treated with the 70 per cent. dust against *T. bimaculatus* in July before being set out in the field showed complete control of eggs and young and more than 75 per cent. kill of adults and remained remarkably free of mites throughout the summer. This dust also gave good control of *Tetranychus* on carnation in greenhouses with only a slight bleaching of red flowers, and on phlox growing in the open, and dusting azaleas brought in from the field in October with 25, 35 or 50 per cent. azobenzene gave excellent control of *Paratetranychus ilicis*, McG., in all cases and of *Brevipalpus* sp. when the dust was well applied.

It is concluded that azobenzene dusts will give good control of most Tetranychids when applied at concentrations of 25 per cent., but that when the quantity of dust applied can be well controlled, one containing 50 per cent. or more azobenzene is to be preferred because of the smaller quantity of inert residue left after dusting. There appears to be considerably less risk of injury to the plants from dusting than from fumigating, and dusting can apparently be carried out at higher temperatures.

FREAR (D. E. H.) & SEIFERLE (E. J.). **Chemical Structure and insecticidal Efficiency.**—*J. econ. Ent.* **40** no. 5 pp. 736–741, 2 refs. Menasha, Wis., 1947.

The authors have collected published and unpublished data on 6,155 chemical compounds that have been tested as insecticides and have classified tests as positive if at least 10 per cent. net toxicity was recorded. They have then assigned the percentages of positive tests to each group contained in the compounds, and give tables of the groups represented by ten or more tests, showing the number of compounds containing them, the number of tests, and the

percentage positive. For example, 451 of the compounds contained the carboxyl group, 518 tests with these compounds were recorded, and 75·5 per cent. of the tests were positive. The carboxyl group is therefore referred to as associated with a toxicity of 75·5 per cent.

The tables show that several organic groups are associated with apparent toxicity of 100 per cent. These are the C_3 ring, the C_2S ring, dinitriles, C_5+C_6 fused ring systems (for example indan) and the C_{13} chain. Since these groups are represented by a limited number of tests, their location in the table is perhaps fortuitous. Among the groups represented by a greater number of tests, the thiocyanates (single and multiple), the polychlor groups (Cl_5, Cl_4, Cl_3 and Cl_2) and the ethers are all associated with high apparent toxicity. Many of the groups associated with the lowest toxicity are represented by small numbers of tests, but many groups containing nitrogen (azo, unsubstituted amide, semicarbazone, diamines, urea and C_3N_2 heterocyclic rings) appear in compounds of low toxicity. Several series show the effect on insecticidal activity of multiplication of like groups in a molecule. It is apparent that compounds containing increasing numbers of chlorine atoms have increasing apparent toxicities, compounds with one, three and five chlorine atoms being associated with 87·3, 89·1 and 95·5 per cent. toxicity. This regular trend is probably of some significance, although there were no significant differences between successive members of the series. Similar trends are observable with one, two and three bromine atoms, though the presence of four appears to result in lower toxicity, but a definite reversal occurs with an increase in numbers of iodine atoms. It appears that the toxicities associated with compounds containing one chlorine, bromine or iodine atom are about the same (80·2–87·3 per cent.), whereas that associated with compounds containing a single fluorine atom is considerably less. Increase of toxicity to a peak when three like groups are present in the molecule, followed by a decrease when more are added, also occurred in the C_2 chain series. Compounds containing two primary, secondary or tertiary amine groups are generally less toxic than those with one, and compounds containing ether linkages or nitro groups also show decreased effectiveness with increase in number of like groups.

The relative order of toxicity of certain of the inorganic cations shows some anomalies that may be removed by the further testing of larger numbers of compounds containing these groups, but the data on inorganic anions are supported by established facts. The fluosilicate, fluoborate, arsenite, arsenate, thiocyanate and fluoride groups are shown to be associated with high toxicity, and the nitrate, phosphate and carbonate groups with low toxicity. The data on groups in which inorganic elements are attached directly to carbon, which may be loosely termed organo-metallic groups, are hardly sufficient to warrant any broad conclusions, but it is significant that the toxicities associated with all these groups are relatively high.

Van Leeuwen (E. R.). **Increasing Production of Codling Moth Eggs in an Oviposition Chamber.**—*J. econ. Ent.* **40** no. 5 pp. 744–745. Menasha, Wis., 1947.

The numbers of eggs laid by females of *Cydia* (*Carpocapsa*) *pomonella*, L., kept at a constant temperature of 80°F. in an oviposition chamber were increased by introducing stimulating materials. These were put in the chamber in a wire cage, the liquids being absorbed on towelling, and the cage was wrapped in waxed paper to keep the moths from contact with the test materials. Egg counts showed that 60 per cent. more eggs were deposited in the presence of water only than in its absence and 787, 168 and 167 per cent. more with apples, apples and water and 10 per cent. molasses bait than with water only. When apples were used, there was a marked decrease in numbers of eggs following a

change from old, partly decayed apples to those fresh from winter storage, and in investigations to determine the time required for fresh apples to increase egg production, in which the same apples were used throughout the experiment, 4,383 eggs were laid in the presence of water and 2,180 in the presence of apples for the first six days after they were taken from storage and 2,950 with water and 4,857 with apples for the remaining four days of the test period.

Ingram (J. W.), Bynum (E. K.) & Charpentier (L. J.). **Effect of 2,4-D on Sugarcane Borer.**—*J. econ. Ent.* **40** no. 5 pp. 745–746. Menasha, Wis., 1947.

Many growers use 2,4-D (2,4-dichlorphenoxyacetic acid) to control weeds in sugar-cane fields, but examination of young sugar-cane plants injured by the first generation of *Diatraea saccharalis*, F., on plots in Louisiana in 1946 showed that infestation averaged 35 borers per acre in plots that had received three sprays of 1 lb. 70 per cent. 2,4-D per acre at intervals of three weeks and only eight per acre on plots that had been hoed often enough to control the weeds.

An experiment was therefore carried out on plots of 0·05 acre, in which 2,4-D was used at 1 lb. per acre in dusts applied at 8 lb. per acre. Two applications of 2,4-D in pyrophyllite at an interval of a fortnight resulted in 50·8 living borers per plot, four of cryolite and sodium fluosilicate only at weekly intervals in 9·8 and 5·3, respectively, and four of cryolite and sodium fluosilicate with the addition of 2,4-D in the second and fourth in 13·5 and 9·8, respectively. There were 35·3 in the untreated plot, and the significant difference was 11·3. All treatments were begun on the same day. Although some of the differences were not significant, it appeared that the use of 2,4-D increased the borer population in plants receiving no other treatment or treatment with cryolite or sodium fluosilicate by 44, 38 and 85 per cent., respectively. Examination three weeks after the last application showed that the average number of eggs of *D. saccharalis* was 230 in untreated plots and 281 in those treated with 2,4-D, and the average percentage parasitism by *Trichogramma minutum*, Riley, 60 in untreated plots and 49 in the treated ones. Since there were 22 per cent. more eggs and 18 per cent. less parasitism in the treated than in the untreated plots, the authors suggest that the heavier infestation may have been largely due to the detrimental effect of the 2,4-D treatment on parasitism by *T. minutum*.

Flanders (S. E.). **Use of Potato Tubers in Mass Culture of Diaspine Scale Insects.**—*J. econ. Ent.* **40** no. 5 pp. 746–747, 2 figs., 5 refs. Menasha, Wis., 1947.

The author describes an inexpensive laboratory method of producing large numbers of various Diaspine scales in preparation for testing how effective their natural enemies would be in the field when released periodically in very large numbers.

Trays of 0·5 inch hardware cloth containing single closely packed layers of small potato tubers are used. When they are to be infested with Coccids that are not highly phototropic, such as *Aonidiella aurantii*, Mask., six or more trays are put in a settling chamber under one that is already heavily infested with scales that are producing young, and the latter either drop naturally or are blown down at intervals. The top tray is removed as soon as all the potatoes in it are infested. To obtain a high degree of infestation with *A. aurantii* and other scales that tend to establish themselves at the point of fall, the potatoes are turned over daily. When *Hemiberlesia* (*Aspidiotus*) *lataniae*, Sign., and other positively phototropic species are used, the newly hatched crawlers can be forced by proper lighting to leave the original tubers and converge at a point where they can be readily collected ; artificial infestation is then accomplished

by dusting the crawlers on to the tubers in the trays. However, allowing the young to drop naturally is the least laborious method. With this species, three infested trays will yield enough young to infest a fresh tray daily for several months ; newly infested trays should be kept in a dark room for a time.

FULTON (B. B.), WHITE (R. C.) & JONES (I.D.). **Fluorine Residue on Cucurbits.**—*J. econ. Ent.* **40** no. 5 pp. 747–749, 6 refs. Menasha, Wis., 1947.

In order to find how much fluorine is likely to be present on fruits of cucurbits dusted with cryolite or barium fluosilicate for the control of *Diaphania nitidalis*, Stoll, in North Carolina, determinations of the fluorine residues were made by a method described. From the results obtained it is concluded that small cucumbers numbering 30 or more per lb. might be expected to have a fairly large fluorine residue when dusted with any cryolite mixture that would be effective against *D. nitidalis* if no rain fell on the plants between dusting and picking. Large cucumbers numbering less than ten per pound would probably not retain a residue of more than 7 mg. per kg. (the U.S. tolerance for apples and pears) even if not wetted by rain. Samples dusted with barium fluosilicate generally retained a larger fluorine residue than those dusted with cryolite. Results from samples that had been washed or wetted by rain indicate that both dusts are rather easily removed from cucumbers and squash and that any simple washing process would probably reduce the residue below 7 mg. per kg. If summer squash crops are picked clean just before dusting, it is doubtful if the next picking would have a very heavy residue even if no rain fell. Cucumbers for commercial pickles are either washed in a vegetable washer or cured in brine that is later removed by several changes of water and may be handled several times while wet during this process. No analyses were made on brined samples, but the results on washed samples indicate that no large residue would be retained on brined pickles even in the small sizes.

BOURNE (A. I.) & SHAW (F. R.). **Chironomid Larvae in a Tobacco Seed Bed.**—*J. econ. Ent.* **40** no. 5 p. 749. Menasha, Wis., 1947.

On 10th April 1947, masses of larvae that were later identified as *Smittia aterrimus*, Mg., were observed on the surface of the soil in a tobacco seed bed [probably in Massachusetts]. Larvae of this Chironomid have been recorded as feeding on the root hairs of various plants, including tobacco seedlings, but they caused no damage in the present instance as pupation and adult emergence were completed before the seedlings were through. On 12th May, there was no sign of the insects, the tobacco seedlings seemed to be developing normally and the stand was as good as in adjoining beds.

The presence of the almost fully developed larvae in the soil could not be explained, but it is considered possible that they had been attracted to a fertiliser containing cotton-seed meal that had been applied before the beds were sown and had migrated from a neighbouring strip of marshy land.

GUNDERSON (H.). **Clover Leaf Weevil Control with DDT Dust.**—*J. econ. Ent.* **40** no. 5 p. 751, 1 ref. Menasha, Wis., 1947.

Hypera punctata, F., appeared in large numbers on red and sweet clover [*Trifolium pratense* and *Melilotus*] in Iowa during May 1947. On 24th May, a light aeroplane was used to apply a dust of 5 per cent. DDT in talc at the rate of 20 lb. per acre. The swath covered on each trip was 30 ft. wide and 17 acres were treated in 15 minutes. On 26th May, it was almost impossible to find living larvae on red clover that had been 50 per cent. defoliated and showed average populations of six larvae of all stages per plant (12 per square

foot) before treatment, although the population was still 4–6 larvae per plant on untreated clover. The treated clover was recovering from the damage, and a definite line of demarcation was visible between treated and untreated portions of the field. In a heavier stand of red clover, which had shown less apparent damage, although populations of 10–12 larvae per sq. ft. were present, about 50 per cent. of the larvae were killed. The difference in results was due to the much denser growth in the second field, which prevented the dust from coating all the leaves.

DEAN (G. A.). **The Lesser Grain Borer in Wheat in the Field.**—*J. econ. Ent.* **40** no. 5 p. 751. Menasha, Wis., 1947.

The author reports that towards the end of June 1947, kernels showing injury by adults of *Rhizopertha dominica*, F., were taken from wheat growing in the field in south-western Kansas.

GRAHAM (C.) & CORY (E. N.). **Codling Moth and European Red Mite Control and Seasonal Analysis of Spray Deposits.**—*J. econ. Ent.* **40** no. 5 pp. 752–754. Menasha, Wis., 1947.

In 1946, 16 schedules comprising sprays of benzene hexachloride, DDT or lead arsenate at the dosages usually recommended, were tested against the codling moth [*Cydia pomonella*, L.] and their effect on the European red mite [*Paratetranychus pilosus*, C. & F.] observed on apple trees in Maryland. All the trees received petal-fall and scab sprays of lead arsenate and sulphur, respectively, and 3–5 cover sprays of the test materials, with Bordeaux mixture in 1–3 of them. Records were kept of the infestation of the fruits by *Cydia* and of the leaves by the mite and of the DDT deposit on the foliage throughout the season. It was found that five applications of 3 lb. benzene hexachloride per 100 U.S. gals., with a spreader, failed to control *C. pomonella*, but all the other schedules were very effective. The addition of oil to DDT increased the residue to beyond the tolerance [*cf. R.A.E.*, A **35** 110] but did not improve the control. Three applications of DDT in May and June gave as good control as five applications. DDT wettable-powder suspensions and emulsified solutions used at double the recommended strengths at approximately 25-day intervals (in May, June and July) gave excellent control, but the trees treated with the powder showed excessive residue on the fruit at harvest. All combinations of oil and DDT, benzene hexachloride alone and with DDT, and the double-strength emulsified solution of DDT resulted in poor foliage throughout the season and poor finish on fruit at harvest. The Bordeaux mixture used with them probably contributed to this.

Although the mite population never became large on any plot, the data indicated that none of the sprays used would have given satisfactory control in a season favourable to mite development. The highest population was found on the plot treated with lead arsenate and lime. The addition of DN-111 [a salt of dinitro-o-cyclohexylphenol] or oil to the DDT sprays failed to give satisfactory mite control.

The deposits of DDT on the foliage varied throughout the season, so that no definite conclusions could be drawn as to the amount necessary for good control of *C. pomonella*, but it appeared that foliage collected on 15th August should bear about 8 grains DDT per lb. and that the deposit should never fall below 3 grains per lb. from the first application of DDT until larval activity has ceased. It is concluded that in years unfavourable for the development of *C. pomonella* good control can be obtained with any of the standard recommended sprays if the applications are timely and thorough.

KNOWLTON (G. F.). **Blue Oat Mite Damage to Wheat in Utah.**—*J. econ. Ent.* **40** no. 5 pp. 754–755. Menasha, Wis., 1947.

In March 1947, *Penthaleus major*, Dugès, was collected from a field of autumn irrigated wheat in Salt Lake County, Utah. Eight acres that had been well fertilised with chicken manure twice at an interval of a year were very heavily infested, and the wheat was severely damaged or killed over approximately an acre. Examination of neighbouring fields of autumn irrigated or dry-farm wheat failed to show equally heavy infestations, but mites were encountered in various other fields 1–3 miles away. They were much less abundant by the middle of April, when the less severely injured plants had largely recovered, and scarce by 16th May, when the surviving wheat was of good colour.

Three predacious mites belonging to the genera *Hypoaspis*, *Gamasus* (*Parasitus*) and *Typhlodromus* were present in the most seriously damaged field, and a mite of the genus *Diphaulocylliba* was also found.

HOERNER (J. L.). **A Separator for Onion Thrips.**—*J. econ. Ent.* **40** no. 5 p. 755, 1 fig. Menasha, Wis., 1947.

A method for facilitating the counting of onion thrips [*Thrips tabaci*, Lind.] on the leaves of onion was developed in the course of investigations made in Colorado in 1945-46 on their control with insecticides. The tops of ten onion plants from a plot were put in a container over a modified Berlese funnel and heated in a temperature cabinet at 116°F. for five hours. At the end of the heating period, all the thrips had fallen into a shell vial containing 70 per cent. alcohol beneath the funnel and could be counted under a binocular microscope.

FREAR (D. E. H.). **Chemistry of Insecticides, Fungicides and Herbicides.**—2nd edn., $9\frac{1}{4} \times 6$ ins., x+417 pp., 38 figs., many refs. New York, N.Y., D. van Nostrand Co., Inc.; London, Macmillan & Co., Ltd.,1948. Price $6 or 33*s*.

The subject matter of the first edition [*R.A.E.*, A **31** 207] has been expanded to include information on DDT, benzene hexachloride and other recently developed insecticides and fungicides, the whole has been rearranged to follow chemical rather than biological lines, and a chapter on herbicides has been added.

PAGÁN (C.) & LOUSTALOT (A. J.). **A simple rapid Method for estimating Toxicity (Rotenone Equivalent) of Derris Root.**—*J. agric. Res.* **77** no. 9–10 pp. 271–277, 4 graphs, 1 ref. Washington, D.C., 1948.

The following is the authors' summary. A quick simple method for evaluating the toxicity of derris roots is described. The method is based on the absorption of light by the toxic constituents of the roots, dissolved in acetone and measured in a spectrophotometer at 360 mμ. When acetone extracts of derris samples were adjusted to equal rotenone content and the percentage of transmittance determined, there was close agreement between the known content of other toxic constituents (rotenoids) and the transmittance values. Likewise, transmittance values of graded rotenone solution in acetone determined at 360 mμ followed the Beer's-Lambert law. The transmittance values of total acetone extractives of derris roots were in close agreement with the rotenone equivalents as determined biologically on houseflies [*Musca domestica*, L.]. Transmittance values of *Lonchocarpus* [cubé] root did not correlate with the biological rotenone equivalent.

Jones (M. A.), Pagán (C.), McGovran (E. R.), Gersdorff (W. A.) & Piquett (P. G.). **A further toxicological Comparison of *Derris* and *Lonchocarpus*.** —*J. agric. Res.* **78** no. 7 pp. 191–196, 5 refs. Washington, D.C., 1949.

The following is from the authors' introduction and summary. In continuation of previous work [*cf. R.A.E.*, A **34** 217; **35** 428] the same species of *Derris* and *Lonchocarpus* [cubé] were compared with some of them represented by samples grown under different conditions. Additional chemical analyses were made in an attempt to trace the toxicity due to compounds other than rotenone. The samples comprised *Lonchocarpus utilis*, *L. chrysophyllus* and three varieties of *Derris elliptica* grown in Porto Rico, one of the varieties of *D. elliptica* grown in Guatemala and *L. utilis* grown in South America. The test insects were house-flies (*Musca domestica*, L.) and larvae of the Mexican bean beetle (*Epilachna varivestis*, Muls.).

When the samples were ranked on the basis of toxicity, rotenone plus natural resins and total chloroform extractives proved to be most nearly in accord with their toxicity to house-flies. The rotenone plus rotenoids ranking was fairly similar to the insecticidal ranking; rotenone content as well as the other chemical characteristics determined showed considerable divergence from the toxicological value.

In general, *Derris* had a higher insecticidal value than *Lonchocarpus* when comparisons were based on equal rotenone content. The *Derris* grown in Porto Rico was much more toxic than that grown in Guatemala, but there was little difference in the *Lonchocarpus* samples from Porto Rico and South America.

The house-fly was more satisfactory than the bean-beetle larva as a test insect for evaluating the relative toxicity of these samples. However, despite the dissimilarity in the manner in which the insecticides were applied, the rankings according to toxicity to the two species agreed when the differences between samples were relatively great.

Pagán (C.) & Loustalot (A. J.). **Comparison of chemical Values with the toxicological Rotenone Equivalent of *Derris* and *Lonchocarpus* Roots.**—*J. agric. Res.* **78** no. 7 pp. 197–205, 2 figs., 10 refs. Washington, D.C., 1949.

During 1942–46, cubé (*Lonchocarpus*) from South America was used almost exclusively in the United States as a substitute for *Derris*, but it appears that its rotenone content is not an adequate criterion of its insecticidal value. The results are given of an unpublished experiment by G. E. R. Hervey in New York in which samples of *Lonchocarpus* and *Derris*, each containing 5 per cent. rotenone, were diluted with talc and tested against *Pieris* (*Ascia*) *rapae*, L., and *Trichoplusia ni*, Hb. (*Autographa brassicae*, Ril.) on cabbage by applying the dusts three times at an average rate of 25 lb. per acre at intervals of about two weeks. In dusts containing 1, 0·5 and 0·25 per cent. rotenone, the *Derris* gave 70·2, 61·5 and 49·3 per cent. control and the *Lonchocarpus* gave 62·5, 56·4 and 49·8 per cent.; the difference between them was significant only at the highest concentration of rotenone. It has also been shown in experiments with different species of *Derris* that one with a low rotenone content may be more toxic than one with a higher content [*R.A.E.*, A **33** 48].

Comparisons were therefore made of values obtained by other criteria when these were applied to various samples of *Derris* and *Lonchocarpus* of which the toxicities (rotenone equivalents) had been ascertained by tests on house-flies (*Musca domestica*, L.). It is concluded from the results that the red-colour value [**34** 218] gives a good indication of the toxicity of *Derris* root, but, like the transmittance value [**37** 259], requires a special apparatus and technique and is thus unsuitable for rapid assays. The percentage of total chloroform

extractives appears to be the simplest and most accurate criterion for estimating the toxicity of *Derris* roots. In the eight *Derris* samples tested the toxicity (rotenone equivalent) was 0·78 of the value for total chloroform extractives. In the case of *Lonchocarpus* root, neither the total chloroform extractives nor the red-colour value appears to be a very good criterion of toxicity. The rotenone content, although negatively correlated with toxicological value, seems to be more indicative.

The results of these laboratory tests and of those from practical field trials strongly suggest that *Derris* and *Lonchocarpus* roots, although they both contain rotenone, should be evaluated separately.

Ross (H. H.). **A Textbook of Entomology.**—$9\frac{1}{4} \times 6$ ins., ix+532 pp., 434 figs., refs. New York, J. Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1948. Price $6 or 36*s*.

An account of the early history of entomology and of the development of economic entomology in North America is followed by chapters on the characters of the different Arthropod classes, and on the anatomy, physiology and life-cycles of insects, and then by one in which the main Orders are considered individually. This includes keys to common families and notes on habits, illustrated largely by reference to insects of economic importance in North America. Other chapters are concerned with the geological history of insects and with ecological factors, and a concluding one contains a general review of the many different types of damage caused by insects and the methods available for their control.

Bawden (F. C.) & Kassanis (B.). **The Behaviour of some naturally occurring Strains of Potato Virus Y.**—*Ann. appl. Biol.* **34** no. 4 pp. 503–516, 1 pl., 19 refs. London, 1947.

The following is virtually the authors' summary. Potato virus Y was obtained from field crops of potatoes in England in many strains that differed widely in virulence and caused diseases in the variety Majestic ranging from severe leaf-drop streak to mild mosaic. The symptoms they caused in seven potato varieties and tobacco are described and compared with those caused by the serologically related potato virus C. No changes were noted in the behaviour of any of the strains over three years, during which they were transmitted to many different plants.

Potato virus C was not transmitted by *Myzus persicae*, Sulz., the most efficient vector of other strains of virus Y [*cf. R.A.E.*, A **33** 378]. Nor was virus C transmitted by eleven other species of Aphids, eight of which transmitted virus Y. The efficiency with which different species acted as vectors of virus Y varied greatly, and it is suggested that in some species only occasional individuals can transmit. Possible mechanisms for the evolution of viruses C and Y are indicated, and the effects of changes in virus, vector, and host on the prevalence of insect-transmitted viruses are discussed.

Lilly (A. H. R.). **Investigations on the Gout Fly (*Chlorops pumilionis* Bjerk.) in Devon and Cornwall.**—*Ann. appl. Biol.* **34** no. 4 pp. 551–561, 5 figs., 4 refs. London, 1947.

The following is almost entirely the author's summary. Field observations from 1943 to 1946 on attacks by *Chlorops pumilionis*, Bjerk., on wheat in Devon and Cornwall, the only parts of England in which it is a major pest of this crop, show that there are two generations during the year, of which the first emerges in May from eggs laid in October and the second in late July and early August.

The bionomics and symptoms of attack on wheat were similar to those recorded on barley in other parts of the country [*R.A.E.*, A **12** 474]. The first generation severely damages spring wheat and may also attack very late sown and backward autumn wheat; wheat not above ground before 20th October escapes attack by the second generation. In south-west England, the optimum period for drilling wheat to escape damage is mid-October. In this area, both generations of *C. pumilionis* show a marked preference for wheat; attacks on barley are negligible.

Jones (D. P.) & Jones (F. G. W.). **Wireworms and the Sugar-beet Crop: Field Trials and Observations.**—*Ann. appl. Biol.* **34** no. 4 pp. 562–574, 2 refs. London, 1947.

The following is virtually the authors' summary. Observations on wireworms in the sugar-beet crop in eastern England during 1937–40 indicated the importance of alternative food, such as buried turf, weeds, excess seedlings and interdrilled wheat in determining the degree of injury to the crop. In 1938, sugar-beet in only one of 36 recently ploughed grass fields suffered severe wireworm damage. Six of these fields were resown with sugar-beet in 1939 and all suffered moderate or severe attacks. Several other fields in their first year from grass showed only slight damage. These observations were supported by an analysis of the Norfolk War Agricultural Committee crop records for 1940.

Seven trials were carried out in 1939 to determine the effect of increasing the seed rate from normal (about 14–16 lb. per acre) to 17–25 lb., and/or of interdrilling with wheat. In three trials, increasing the seed rate gave significantly higher plant populations before singling. It gave significant increases after singling in one out of two trials. However, in the one trial harvested, the increase in yield of washed beet was only 7·6 per cent. and that of total sugar 15 per cent. Interdrilling with wheat at 40–70 lb. per acre gave significant increases in the plant population before singling in three out of five trials, and after singling in three out of four. Increased plant populations both before and after singling were obtained in two other trials with alternating treatments. Increased seed rate and interdrilled wheat together gave greatly improved plant populations before singling in each of two trials and after singling in the one trial where observation was possible.

Hewlett (P. S.). **The Toxicities of three Petroleum Oils to the Grain Weevils.**—*Ann. appl. Biol.* **34** no. 4 pp. 575–585, 4 figs., 12 refs. London, 1947.

The following is based on the author's summary. The toxicities of Shell oil P31, odourless distillate (O.D.) and Pool burning oil (P.B.O.) to adults of *Calandra granaria*, L., and *C. oryzae*, L., were determined. These oils are, respectively, highly refined oil of the medicinal paraffin type, a highly refined kerosene and a cruder kerosene. *C. oryzae* was more resistant than *C. granaria* to a direct spray of P31 at 20 and 25°C. [68 and 77°F.] and to direct sprays of O.D. and P.B.O. at 20°C. Under all experimental conditions, P31 was more toxic to both species than P.B.O., but O.D. ranged in toxicity from equality with P31 to equality with P.B.O. according to the different circumstances. Films of P31 or an emulsion of it in water, which was included in the tests because oil emulsions were extensively used against *C. granaria* in Germany during and prior to the recent war, both applied to brick at dosages sufficient to leave deposits of up to 15 mg. per sq. cm., and films of P31 applied to sacking and cement to leave deposits of about 2·5 mg. per sq. cm., were not toxic to

C. granaria, but films of P31 at the same dosage on cement pre-treated with gelatin [*cf. R.A.E.*, A **37** 137] were highly toxic. *C. oryzae* was more resistant than *C. granaria* to films of P31 on Whatman no. 544 filter paper. In a direct spray test, adults of both species that received doses of P31 a little in excess of those sufficient to knock them down rarely recovered completely. In a discussion of the mode of action of the oil, it is concluded that it probably suffocates the beetles by blocking their spiracles or tracheae or both.

P31 showed considerable promise for the control of *C. granaria* and appears to be the most useful of the three oils for this purpose. In practice, it should be effective applied alone as a direct spray and could therefore be used to control infestations in which the beetles were exposed. Preliminary laboratory tests indicated that a dosage of 1·5 mg. per sq. cm. should give 95 per cent. mortality. P31 might be used successfully as a film on surfaces that had been suitably pretreated.

McIntosh (A. H.). **Relation between Particle Size and Shape of insecticidal Suspensions and their Contact Toxicity. I. D.D.T. Suspensions against** *Tribolium castaneum* **Hb.**—*Ann. appl. Biol.* **34** no. 4 pp. 586–610, 1 pl., 7 figs., 15 refs. London, 1947.

The following is the author's summary of his investigations, some of the results of which have already been noticed from a briefer account [*R.A.E.*, A **36** 376]. Fairly coarse aqueous DDT suspensions can be made by the exchange of solvent method [**33** 379]. By varying the method of preparation the mean size of crystal in suspension can be altered. The principles involved are outlined, and methods and apparatus are described for the preparation of the following suspension types: colloidal DDT, a suspension containing elongated hexagonal plates, a suspension of somewhat elongated two-dimensional aggregates of plate-like crystals, and three suspensions of needle-shaped crystals of different lengths. All the DDT crystals are of the same fundamental crystal habit. These suspension types were selected to study the effect of both crystal size and shape on toxicity. The suspensions were tested against *Tribolium castaneum*, Hbst., using a recently developed dipping technique [**37** 138]. It was shown that the results obtained were independent of any operation peculiar to the technique. Suspensions tested by a spraying method gave data similar to those obtained by dipping, except for certain anomalous results obtained where the crystals were considerably broken up in passing through the spray nozzle. Toxicity differences were assessed by the probit method [**22** 440]. The lines obtained for the crystalline suspensions were generally parallel to one another, but the colloidal DDT gave a line differing in slope from the others.

The dipping tests showed that, within the range of crystal sizes up to about 400μ, toxicity increased with increasing needle length; breadth was less important, but a suspension of needle-shaped crystals was as toxic as one containing considerably larger plate-shaped crystals at the same weight/volume concentration. Colloidal DDT was less toxic than any crystalline suspension. Thus, taking the median lethal concentration for 400μ needles as 100, the values for the other types were: for 120μ needles, 210: for plate aggregates (240$\times$140μ), 260; for 40μ needles, 390; for 60$\times$15μ plates, 510; and for colloidal DDT, 1,700. These differences in toxicity were largely paralleled by retention of greater amounts of DDT from the coarse suspensions than from finer ones; two extreme types were of almost identical toxicity, comparing the percentage kills produced by equal amounts of poison retained, and not by equal concentrations in suspension. The methods of carrying out these retention tests are described.

Baptista (J. E.). **Cotton Seed Disinfection as a supplementary Control Measure for Pink Bollworm (*Platyedra gossypiella* Saund.) in Mozambique.** —*J. ent. Soc. sthn Afr.* **9** no. 2 pp. 111–114, 5 refs. Pretoria, 1947.

Platyedra gossypiella, Saund., is widely distributed on cotton in Mozambique, and one of the control measures adopted was treatment of the seed to destroy the long-cycle larvae, though it was not known that they occur there. After no larvae had been observed in seed from areas that had been infested for a considerable time, 186 samples of cotton seed of different grades from the most important cotton areas, comprising in all about a million seeds, were collected in the gins in 1944 and 1945. One small portion from each, comprising some 250 seeds selected at random, was examined to determine the rate of infestation, another, consisting of bored seeds and seeds suspected of being infested, was examined microscopically, and the remainder was kept under observation for the emergence of moths. No moths emerged, and no infestation was noted by the first method of examination, but microscopic examination revealed the presence of insect remains representing an estimated infestation of 0·4 per cent. in eight samples. Fragments of larvae found in one sample and the remains of a pupa in another might have represented insects that had died during the period between collection and examination, which in general was long. Living larvae and pupae possibly occur in the seeds before ginning, and seeds ginned immediately after harvest might therefore contain living insects.

The diapause of the larvae is induced by a change in nutrition from green bolls, which they prefer, to ripe ones [*R.A.E.*, A **28** 532]. Since some green bolls are always present in Mozambique, and since infestation there is not very heavy, the disinfestation of seed destined for areas where *P. gossypiella* is known to occur is not considered justifiable.

Nel (R. G.) & Dürr (H. J. R.). **The Rate of CO_2 Production by Cockroaches dusted with DDT and other insecticidal Dusts.**—*J. ent. Soc. sthn Afr.* **9** no. 2 pp. 115–126, 1 fig., 12 graphs, 2 refs. Pretoria, 1947.

The following is virtually the authors' summary. Tests with immature cockroaches showed that DDT and, to a lesser extent, pyrethrum powder have a stimulating effect on respiration as expressed by the carbon-dioxide output. This is probably mainly due to direct stimulation of the mechanism of respiration. Almicide (a recently developed inert dust for the control of grain insects) shows an initial accelerating effect on respiration, probably due to increased activity resulting from mechanical or chemical irritation. Talc and mercuric chloride (corrosive sublimate) gave only a slight increase in the carbon-dioxide output, while the effect of sodium fluoride was negligible.

Coaton (W. G. H.). **The Pienaars River Complex of Wood-eating Termites.**— *J. ent. Soc. sthn Afr.* **9** no. 2 pp. 130–177, 31 figs., 8 refs. Pretoria, 1947.

Tests of the resistance to termites of various treated and untreated native woods have been in progress in the Transvaal for many years [*cf. R.A.E.*, A **13** 283]. The present testing ground near the Pienaars River was enclosed in December 1944, and a preliminary survey of it was made to determine the identity, distribution and relative importance of the species responsible for the rapid destruction of exposed wood, so that treated samples might be exposed to the best advantage. To do this, 902 pegs cut from dried saplings of *Eucalyptus saligna* from which the bark had been removed were hammered into the soil at five-foot intervals over the area. Some were heavily infested by *Microtermes* spp. after a fortnight, but there was then little evidence of feeding by other species. All the pegs were examined six weeks after the beginning of

the test, and over 75 per cent. of them were found to be infested, mostly by fungus-growing species, to which group the most destructive South African termites belong. In all, twelve species, all of which construct subterranean nests, were concerned ; their feeding and nesting habits are described. The percentages of pegs infested and (in brackets) the maximum percentage destruction to any one peg above and below ground, respectively, were 8·3 (90 and 100) for *Macrotermes natalensis*, Hav., 2·9 (2 and 50) for *Odontotermes* (*Termes*) *transvaalensis*, Sjöst., 3·9 (5 and 70) for *O.* (*T.*) *badius*, Hav., 2·3 (1 and 10) for *O.* (*T.*) *latericius*, Hav., 6·9 (1 and 40) for *Protermes schultzei*, Silv., 55·5 (50 and 100) for three species of *Microtermes* (*M. havilandi*, Hlmgr., *M. lounsburyi*, Fuller, and *M. etiolatus*, Fuller) that are indistinguishable in the field, 9 (0 and 30) for *Microcerotermes mzilikazi*, Fuller, 3·7 (0 and 5) for *Amitermes* sp. and 1·3 (0 and 1) for *Termes* (*Mirotermes*) *dumisae*, Fuller, and *T.* (*M.*) *lounsburyi*, Silv. All except the last four of these are fungus growers, and the first four have been recorded as damaging buildings in South Africa. *Trinervitermes* sp. and *Hodotermes mossambicus transvaalensis*, Fuller, were found in the soil near the pegs, but as both feed solely on grass and small shrubs, their presence was of no significance.

The system of grading was not entirely satisfactory, since the four species known to damage buildings had not time enough to locate the pegs, owing to their centralised nesting habits and more or less permanent system of passages to the feeding grounds. Undamaged pegs were left lying on the ground, and four months later very few had escaped attack and many were completely destroyed. Pegs showing 90–100 per cent. damage were attacked by *Macrotermes natalensis* and *Microtermes* spp., those with up to 80 per cent. by *Odontotermes* spp. and those with up to 50 per cent. by *P. schultzei* and *Microcerotermes mzilikazi*. Termite attack was uniformly distributed over the area, and the three species of *Microtermes*, which have hitherto been regarded as of no economic importance, were the most uniformly and densely distributed. The damage caused by the different species is described, and the subdivision of the testing ground into experimental blocks in which potential infestation is fairly evenly balanced is discussed ; conditions on this ground are thought to be as stringent as are likely to occur anywhere in South Africa. Keys to the species found, based on the nesting habits and on morphological characters of the soldiers, are appended.

GEYER (J. W. C.). **A Study of the Biology and Ecology of *Exochomus flavipes* Thunb. (Coccinellidae, Coleoptera). Part I.**—*J. ent. Soc. sthn Afr.* **9** no. 2 pp. 219–234, 17 figs. Pretoria, 1947.

Dactylopius opuntiae, Ckll., which was introduced into South Africa to control prickly-pear [*Opuntia*], is severely attacked there by a native Coccinellid that was previously thought to be *Exochomus melanocephalus*, Zoubkoff, but has now been identified as *E. flavipes*, Thnb. [*cf. R.A.E.*, A **30** 563 ; **32** 397 ; **36** 389]. *E. melanocephalus* is confined to the Soviet Union. *E. flavipes* apparently occurs throughout the Ethiopian Region, and is of some value in South Africa as a natural enemy of the woolly aphis [*Eriosoma lanigerum*, Hsm.] on apple [*cf.* **28** 375] and of mealy bugs and other injurious Coccids [*cf.* also **32** 163 ; **33** 86]. This paper contains an account of field and laboratory investigations of its bionomics carried out in the eastern Cape Province in 1942–43, the food, except in special tests, being *D. opuntiae*.

The adults began to feed a day or two after emergence, but there was a relatively long interval between emergence and mating, though oviposition was then not long delayed. The eggs were deposited singly, in pairs or irregularly arranged among examples of *D. opuntiae*, in crevices or in empty pupal cases of *E. flavipes* from which parasites had emerged. Unfertilised females laid

a few eggs, but none of these hatched. The larvae passed through four instars, the duration of which was determined chiefly by temperature. They were parasitised by *Homalotylus* sp., which appeared to kill its host in the third or fourth larval instar or in the pupal stage, but monthly parasitism of pupae by this Encyrtid at four places averaged only 1·5 per cent. and only 1·4 per cent. of fourth-instar larvae collected at one of them in January 1943 were parasitised. Two parasites can develop in one host. *Homalotylus* sp. was itself parasitised by a species of *Pachyneuron*. Two other Encyrtids, *Cheiloneurus* sp. and *Ooencyrtus* sp., were reared from the pupae of *Exochomus*, as well as two undetermined apterous Bethylids. When kept in a saturated atmosphere at 86°F., the eggs and pupae were attacked by fungi of the genera *Macrosporium* and *Aspergillus*, respectively. Five generations were produced during the year in the laboratory, and climatic conditions would also allow this number to develop in the field. Reproduction continued throughout the year, but was slower in winter. Mortality during the pupal stage, due to unfavourable weather and natural enemies, was 48·9 per cent. Males and females were produced in a ratio of 2 : 3.

Experiments were made on the feeding habits of the adults and larvae. The latter suck the body fluid of crawlers of *D. opuntiae* and Aphids, and, if starved, attack eggs and weak larvae of their own species. In October 1942, adults at a place where *D. opuntiae* had become scarce on prickly-pear were observed to migrate to *Euphorbia ledienii* and feed on the nectar in the flowers. Examples fed on blossoms of *E. ledienii* in the laboratory survived significantly longer than starved ones and for significantly less time than those fed on *D. opuntiae*. In a test of the effects of an exclusively carbohydrate diet, beetles fed on cane sugar and water survived for considerably longer than others fed on honey and water, but mating and oviposition did not occur in either case. Studies of the digestive enzymes present in the adults and larvae also provided evidence that they can subsist on carbohydrates for a limited period. Other experiments showed that the fourth-instar larvae cannot complete their development without regular, large supplies of food. The average survival periods of adults fed constantly, at five-day intervals and not at all were 163·1, 62·1 and 13·9 days, respectively, but adults fed at five-day intervals on *D. coccus*, Costa, another species of the same genus closely related to *D. confusus*, Ckll. [*cf.* **28** 375] or *Aonidiella aurantiae*, Mask., instead of *D. opuntiae*, lived only about one-third as long. Since Diaspine Coccids are protected by their scale coverings from attack by the Coccinellid, it is assumed that in nature only the nymphs, females exposed as a result of mechanical injury, and probably the males are eaten.

Ullyett (G. C.). **Host Adoption by Hymenopterous Parasites.**—*J. ent. Soc. sthn Afr.* **9** no. 2 pp. 236–237, 2 refs. Pretoria, 1947.

Two examples are given of introduced insect pests in South Africa being attacked by native parasites. One of these is *Plutella maculipennis*, Curt., which is attacked there by a complex of indigenous species that can exert very efficient control [*R.A.E.*, A **32** 432] and is almost identical in generic composition with that attacking it in Europe. The most important is a species of *Angitia* [*cf.* **32** 87] so closely related to the introduced European *A. cerophaga*, Grav., that they interbreed in the field. The other is *Cydia* (*Carpocapsa*) *pomonella*, L., which is becoming increasingly difficult to control by means of insecticides, but has in recent years been attacked by native parasites in unsprayed orchards. These include *Trichogramma luteum*, Gir., *Cremastus* sp., *Pimpla heliophila*, Cam., and *Cryptus* sp. [*cf.* **31** 219] and also two larval parasites, *Apanteles leucotretae*, Ullyett, and *Phanerotoma curvicarinata*, Cam., which were reared in 1945–46 from infested unsprayed pears in the Transvaal.

With the exception of *Pimpla heliophila*, all have also been reared from the native *Argyroploce* (*Olethreutes*) *leucotreta*, Meyr., the habits of which resemble those of *C. pomonella*. They were not recorded earlier from *C. pomonella* either because they have only recently begun to attack it or because of the severe spray programme employed against it, and they will not become of value in its control unless the present measures are discontinued or considerably modified.

It is concluded that where a native insect closely resembles an introduced pest in habits and general environmental requirements, the possibility of its parasites attacking the introduced species should be considered when devising control measures against the latter, and likely ones should be encouraged to adopt it as an alternative host as early as possible.

Ripley (L. B.), Petty (B. K.) & Hepburn (G. A.). **Soil Insecticides for the Citrus Snout-beetle.**—*Sci. Bull. Dep. Agric. S. Afr.* no. 259, [4+] 18 pp., 5 figs. Pretoria, 1947.

Sciobius granosus, Fhs., is widely distributed in South Africa and is injurious to *Citrus* in irrigated orchards in the Muden Valley of Natal, the adults feeding on the foliage and the larvae on the roots. The eggs are laid between mid-November and mid-March in masses enclosed in folded leaves on the soil under the trees, and hatch in about nine days. The larvae immediately enter the soil and feed externally on the root cambium. The weevil can be controlled by means of a mechanical trap placed on the trunks of the trees, but since a cheaper and simpler method is needed, an attempt was made to discover a suitable soil insecticide for use against the eggs and newly-hatched larvae.

The following is based on the authors' summary. The periods for which some 70 compounds remained toxic in the soil was tested by mixing each with soil to give a concentration of 0·36 per cent. by weight, keeping them under constant conditions in a ventilated incubator, and periodically determining the toxicity to newly hatched larvae. Of these compounds, 16 were persistent enough to be of some value as soil insecticides, and the six best were selected for further investigation. These were polymethylnaphthalenes, inter-still residue, light creosote, heavy creosote, chlorcresol and a mixture of equal parts of xylenol and cresol. Many compounds with high initial toxicity were too volatile to give good results for long, whereas those with relatively low initial toxicity sometimes proved effective because of their persistence. Inter-still residue, which is stated to contain 20 per cent. (by volume) naphthalene, 18 per cent. monomethylnaphthalene, 18 per cent. coumarone, 5 per cent. phenols, 3 per cent. tar bases, 0·7 per cent. anthracene and small amounts of pseudo-cumene and di- and polymethylnaphthalenes, was the most satisfactory of the products commercially available. It gave over 85 per cent. mortality of newly-hatched larvae for more than eight weeks in both laboratory and field, so that only two applications would be required to protect the trees throughout the oviposition period. This unusual persistence of toxicity appears to be due to the polymethylnaphthalenes, which also confer exceptionally high initial toxicity. For the most promising compounds, a concentration of 0·36 per cent. by weight was sufficient to give the required duration of toxicity (eight weeks) when applied to the surface of the soil and raked in to a depth of two inches. The dose per tree varied from 1 to 4 lb., according to the radius of the circle treated. One of 6 ft. was used in the first tests, but this was later reduced to 3 ft., since evidence provided by A. J. Fourie indicated that most larvae occur within 3 ft. of the trunk; it is not certain, however, that the smaller area is large enough.

Duration of toxicity is the best criterion of the value of a soil insecticide against *S. granosus*, but the ability of the newly-hatched larvae to penetrate

through a two-inch layer of treated soil also provides a valuable index. It depends not only on the toxicity of the compound, but also on its anaesthetising effect, and other physiological effects are also contributory. Polymethylnaphthalenes and inter-still residue at a concentration of 0·36 per cent. allowed no appreciable penetration or survival until the ninth week after application. The extent to which the vapour from the treated layer permeates downwards into the untreated soil is also important. Soil 2–4 ins. below a layer treated with inter-still residue gave high mortality ; chlorcresol penetrated much less.

The eggs were extremely susceptible to very dilute vapours from several of the compounds. The mixture of xylenol and cresol and chlorcresol were the most potent ovicides, but inter-still residue at an initial concentration of 0·36 per cent. killed all eggs on the surface of the soil for up to five weeks after application. Adult beetles kept in atmospheres odorised by chlorcresol, the xylenol-cresol mixture or heavy creosote fed normally, but their survival period was slightly reduced and oviposition somewhat stimulated. Spermatozoa in the seminal receptacles of the females were not affected. Under field conditions no appreciable effect on the adults is to be expected. Inter-still residue and chlorcresol resist loss by heavy rains to a surprising extent, and gave fairly high mortality even after the orchards had been flooded.

In further laboratory tests, reported in an appendix, DDT at a concentration of 0·36 per cent. proved ineffective against the larvae and allowed many to penetrate the treated layer, but pentachlorphenol was superior even to the best of the materials previously found, giving complete mortality of larvae after 11 weeks. When freshly mixed with soil at concentrations designed to show relative initial toxicity, 0·019 per cent. pentachlorphenol and inter-still residue gave 25 and 40 per cent. mortality, respectively, and 1 per cent. DDT 30 per cent. Pentachlorphenol was as effective as polymethylnaphthalenes in preventing penetration of treated soil for eight weeks after application but deteriorated much less rapidly thereafter, allowing only 40 per cent. of larvae to penetrate after 11 weeks ; all those that did so died. It had no ovicidal effect, probably owing to its low volatility.

TOOKE (F. G. C.). **Beetles attacking seasoned Timber in South Africa. Part 2. The Bark Anobiid—*Ernobius mollis* Linn. and Keys to the common Insect Pests of Timber and to common Insect Damage to Timber in South Africa.**—*Bull. Dep. Agric. S. Afr.* no. 267, 12 pp., 4 figs. Pretoria, 1946.

In this bulletin, which is part of a series [*cf. R.A.E.*, A **34** 333], it is stated that *Ernobius mollis*, L., was first observed in South Africa in 1937 at a sawmill at George, where it had been introduced in imported packing cases made of rough-sawn pine with much bark on the inside. It spread rapidly to seasoned coniferous timber throughout the Union, but is of only secondary importance since it can be controlled by removing the bark. All stages and the bionomics of the Anobiid are described ; there is normally one generation a year, with sometimes a partial second. The bulletin also contains two keys to various groups or species of insects that commonly infest timber in South Africa, one based on morphology and the other on the types of damage caused.

GARDINER (J. G.). **Report of the Minister of Agriculture for the Dominion of Canada for the Year ended March 31, 1946.**—235 pp. Ottawa, 1946.

In the plant pathology section (pp. 33–55), it is stated that removing or destroying the tops of potato plants as soon as the Aphid vectors of the leaf-roll and potato-mosaic viruses appear proved so successful in maintaining vigorous virus-free stock in Prince Edward Island that it was adopted by many growers. The tops can be removed by hand in small plots and sodium arsenite killed them

satisfactorily over larger areas. In Ontario, the use of sprays of DDT combined with fungicides on potatoes resulted in increased yields owing largely to almost complete control of the potato leaf-hopper [*Empoasca fabae*, Harr.] ; control of flea-beetles [*Epitrix cucumeris*, Harr.], Aphids and the potato beetle [*Leptinotarsa decemlineata*, Say] was satisfactory [*cf. R.A.E.*, A **36** 165].

In the entomology section (pp. 63-83), similar results with DDT against the same potato insects are reported from other parts of Canada ; even low concentrations gave virtually complete control of *Empoasca fabae*, with yields increased by 100 per cent. or more. In British Columbia, sprays and dusts of DDT effectively controlled the adults of the tuber flea-beetle [*Epitrix tuberis*, Gentner], but not the larvae, which were abundant in the tubers, whereas arsenicals were ineffective against the adults, but appeared to have greatly reduced the larvae. In Ontario, DDT dusts were equal, if not superior, to any other insecticide in controlling the tobacco hornworm [*Protoparce sexta*, Joh.] on tobacco. A good-quality variety of canning pea that is resistant to the pea aphis [*Macrosiphum onobrychis*, Boy.] was developed in Quebec and proved to be inferior only to the one other variety in the irrigation area of Alberta. In the latter Province, dusts containing DDT, rotenone or a thiocyanate (Lethane) all gave satisfactory control of *M. onobrychis*. The carrot rust fly [*Psila rosae*, F.] in British Columbia was controlled by naphthalene flakes broadcast during the oviposition period. The wheat stem sawfly [*Cephus cinctus*, Nort.], which occurs over the greater part of the wheat-producing areas of Saskatchewan and Alberta, continued to be the most important pest of grain, and, despite a control campaign, caused losses of wheat estimated at 15–20 million bushels. Evidence indicates that its importance can be greatly reduced for several years by growing Rescue wheat [**37** 108, 233] for one season. Say's stinkbug [*Chlorochroa sayi*, Stål] caused local damage to wheat and flax in Alberta [*cf.* **35** 97]. The grasshopper outbreak was much reduced in 1945, and occurred mostly in south-western Saskatchewan and southern Alberta. *Pyrausta nubilalis*, Hb., which in some years appears in New Brunswick, was present there in greater numbers than ever before and caused serious damage to maize in the St. John Valley.

DDT appeared to be the most effective insecticide yet discovered against the pear thrips [*Taeniothrips inconsequens*, Uzel], which was locally very destructive in British Columbia, and dusts containing it gave outstanding control of the black army cutworm [*Actebia fennica*, Tauscher] on blueberry in New Brunswick. The apple sawfly [*Hoplocampa testudinea*, Klug] and the pear psylla [*Psylla pyricola*, Först.] were very resistant to DDT. Hive bees caged with foliage sprayed with it quickly died, but bees collected from sprayed flowers did not, and a colony in an orchard that was sprayed four times with DDT and in which a buckwheat cover crop was sprayed twice while in bloom remained healthy and vigorous.

Various sprays were tested against orchard pests in British Columbia. Previous experiments there had shown that xanthone was effective against *Cydia* (*Carpocapsa*) *pomonella*, L., on apple but caused russetting of the fruit where used in the earlier cover sprays. In 1945, it gave good control of *C. pomonella* and excellent control of the Pacific and European red mites [*Tetranychus pacificus*, McG., and *Paratetranychus pilosus*, C. & F.], and produced fruit of superior appearance when applied in all the cover sprays except the first two. Micronised phenothiazine considerably reduced *C. pomonella* in three orchards in which it was used on a commercial scale at a concentration of $\frac{3}{4}$ lb. per 100 gals. with the addition of 1 quart stove oil. It was not included in the last cover sprays and therefore did not spoil the appearance of the fruit. Though somewhat less effective than DDT, it does not encourage the development of such large populations of mites and leaves a harmless residue. Bunker oil of suitable viscosity with fixed nicotine controlled

C. pomonella for the fourth successive season, but an oil with a viscosity of 100 S.S.U. applied late left a dark brown residue that affected the colouring of the fruit ; it was, however, more effective than one with a viscosity of 65 S.S.U. These oils are cheap and no more injurious to the foliage than highly refined oils. The dicyclohexylamine salt of dinitro-o-cyclohexylphenol, applied at 5 oz. per 100 gals. with cryolite and casein-lime spreader (3 oz. lime) in all cover sprays, gave some control of *T. pacificus* and *P. pilosus*, and this was increased when ammonia was substituted for the lime in the spreader, showing that the small amount of lime was enough to affect the dinitro compound. The ammonium salt of the latter, prepared in the spray tank, compared well with the more expensive dicyclohexylamine salt. Populations of *P. pilosus* on trees sprayed with dormant oil were smaller than those on unsprayed trees early in the season and larger later. Summer oil sprays considerably reduced numbers of mites and eggs, but dormant oil followed by two applications of summer oil was necessary for good control. Dormant oils with viscosities of 200–220 S.S.U. were more effective against the San José scale [*Quadraspidiotus perniciosus*, Comst.] and *P. pilosus*, but not the apple mealybug [*Phenacoccus aceris*, Sign.], than those of 100–110 S.S.U. at present recommended. Oil with a viscosity of 200 S.S.U. applied undiluted to the trunks of apple trees in four successive springs caused less injury than one with a viscosity of 100 S.S.U. and considerably less than another with a viscosity of 32 S.S.U. or than diesel fuel oil with a viscosity of 40 S.S.U. Stove oil was the most injurious. An emulsion of an oil with a viscosity of 100 S.S.U. applied to dormant pear trees delayed bud development more than one of 200 S.S.U. in each of three seasons, and in 1945 caused a similar delay on apple trees of two varieties. A dormant spray containing 2 gals. oil and 1½ lb. 40 per cent. DNC (dinitro-o-cresol) per 100 gals. was at least as effective against *A. perniciosus* as the recommended spray of 4 gals. oil, and more effective against the oyster-shell scale [*Lepidosaphes ulmi*, L.] than the recommended spray of 5 gals. oil. The mixture is also effective against *Phenacoccus aceris*, the rosy apple aphis [*Anuraphis roseus*, Baker], black cherry aphis [*Myzus cerasi*, F.] and other Aphids that overwinter as eggs on fruit trees.

An outbreak of *M. cerasi* occurred in Ontario for the first time in four years but was satisfactorily controlled by a spray containing 2 lb. 40 per cent. DNC in 100 gals. water applied before the eggs hatched ; ½ lb. Elgetol (a preparation containing sodium dinitro-o-cresylate) also gave good control. In this Province, the effectiveness of DDT against *C. pomonella* was not increased by the addition of xanthone to the sprays, and the xanthone did not reduce the numbers of *Paratetranychus pilosus*, which were not large. Spray schedules containing DDT were less effective than the standard lead-arsenate schedule against the grape berry moth [*Polychrosis viteana*, Clem.] in both 1944 and 1945, and the addition of summer oil to the lead arsenate sprays, which showed promise in 1944, gave disappointing results in 1945.

The cause of the outbreak of *L. ulmi* that has developed in apple orchards in Nova Scotia since 1930 is now known to be interference with natural control agents by the use of mild sulphur sprays ; when sulphur sprays are replaced by other fungicides, its numbers are quickly reduced [*cf.* **36** 270].

The outbreak of spruce budworm, *Choristoneura* (*Archips*) *fumiferana*, Clem., in Ontario and Quebec [**35** 99] decreased in intensity during the year, but there were some extensions of the infested area. Where the outbreak had been most severe, almost all of the balsam [*Abies balsamea*] and more than half of the associated white spruce [*Picea glauca*] was killed. Infestation did not increase significantly in the Maritime Provinces. In New Brunswick, the composition and age classes of a stand under investigation were found to have been determined largely by the activity of the budworm in the past ; 85–90 per cent. of the softwoods survived the last outbreak, presumably because they

were young and therefore resistant, and have now become susceptible. The jack pine budworm [the form of *C. fumiferana* that attacks *Pinus banksiana*] has been a major pest of this tree in Manitoba and north-western Ontario since 1935, but its numbers declined very greatly during 1945, largely owing to parasites and predators. The pupal parasites appeared to have reached equilibrium with their host at its low density. When larvae of the two forms of *C. fumiferana* were reared on various food-plants, those that developed on the preferred plants produced the most fertile and fecund adults. Spruce-budworm moths reared on balsam were the most fecund of all, which explains the susceptibility of stands including this tree. Infestation of larch by *Pristiphora erichsoni*, Htg., increased in the Prairie Provinces. An investigation of the status of parasites introduced against it showed that *Mesoleius tenthredinis*, Morl., which was released in Manitoba in 1912–13, occurred throughout stands of larch in the southern and central parts of the Province, but was not very effective owing to the low viability of the eggs. *Ptychomyia selecta*, Mg. (*Bessa harveyi*, Tns.), which was released during 1939–42, was well established at liberation centres, but had not spread to any extent. In British Columbia, outbreaks of the mountain pine beetle [*Dendroctonus monticolae*, Hopk.] threatened to destroy large stands of timber in the Yoho and Banff National Parks. The outbreak of black-headed budworm [*Acleris variana*, Fern.] [*cf.* **34** 320, 377-379] was brought under control during the year by egg parasites and a virus disease, but it had destroyed high-quality coast hemlock [*Tsuga*] over an area of some 20 square miles. An outbreak of hemlock looper [*Lambdina (Ellopia) fiscellaria*, Gn.] [*cf.* **34** 377] occurred over an area of 150 square miles in an over-mature stand severely affected with rot, and another, involving some 500 square miles of the finest timber on the West Coast, was discovered in Vancouver Island, where trees over many square miles were almost totally defoliated.

A list is given of pests against which parasites were liberated during the year. The breeding and liberation of European parasites of *Cydia pomonella* were continued, and *Cryptus sexannulatus*, Grav., was recovered in some numbers from the Niagara Peninsula, where it had previously been liberated [**33** 356]. An analysis of records from south-western Manitoba during 1938–45 showed that grasshoppers decreased and their parasites increased in numbers during 1940–45. *Phytodietus fumiferanae*, Rohw., a parasite of *Choristoneura fumiferana* in British Columbia that was introduced into Ontario [**36** 78], was found to be established in an experimental area. Liberations of laboratory-reared parasites of the spruce sawfly, *Gilpinia hercyniae*, Htg., were continued in the Eastern Provinces and Newfoundland. Recoveries in Quebec showed that *Sturmia* sp. was present throughout an area extending at least 50 miles from the liberation point ; parasitism by this Tachinid reached 66 per cent. near the liberation point and over 50 per cent. at several other places within a range of seven miles. It was also responsible for a high degree of parasitism in New Brunswick. Three additional species of *Exenterus* were recovered from the sawfly larvae in numbers indicating their establishment and increase. Parasites of the European larch case-bearer, *Coleophora laricella*, Hb., introduced in 1936–39 [**33** 142] were well established near Belleville, where parasitism by three species exceeded 80 per cent., and at another place in Ontario. Parasites of the pea moth *Cydia (Laspeyresia) nigricana*, Steph., introduced into British Columbia in 1937–40 were first recovered in 1942 and increased in numbers in each subsequent year until the combined parasitism by two species [*cf.* **32** 263 ; **34** 73] among larvae collected in a heavily infested field reached 86 per cent. in 1945. Introduced parasites of *Pyrausta nubilalis* [**34** 320 ; **35** 99] continued to increase their range in Ontario, and *Eulophus viridulus*, Thoms., and *Macrocentrus gifuensis*, Ashm., were reared in the laboratory for liberation in Quebec and New Brunswick. An improved rearing technique

enabled *E. viridulus* to be produced in large numbers and, in addition to those released in Canada, over 50,000 were shipped for liberation in the United States.

Coppel (H.) & House (H.). **A Description of Cages used for the large-scale Breeding of *Sturmia* sp., a Tachinid Parasite of Sawflies.**—*Canad. Ent.* **79** no. 4 pp. 74–80, 5 figs., 4 refs. Guelph, Ont., 1947.

During work on the control of *Gilpinia hercyniae*, Htg., on spruce in Canada, it was decided to propagate the introduced parasite, *Sturmia* sp., in numbers sufficient for widespread distribution, and to effect this, it was necessary to devise new methods of propagation. Descriptions are given of the technique and equipment finally adopted, which were used successfully in continuous laboratory work during 1945 and 1946.

Since the technique depends on the life-history of the fly, a brief account of this is given. At 73°F. and 60 per cent. relative humidity, the life-cycle lasts 25 days. Freshly emerged females are mated with males 4–5 days old. The preoviposition and oviposition periods last 5 and at least 30 days, respectively. The eggs are laid on the host larvae, and the larvae hatch immediately and enter the body cavity of the host through the integument. They consume the body contents and become full-fed in 8–12 days, after which they leave the host remains and pupate. The pupal stage lasts 10–15 days, and males usually emerge 1–2 days before the females.

By former breeding methods, only 75 ovipositing females could be handled satisfactorily by one attendant, but by accommodating the host larvae in open-topped sliding drawers in the bottom of the oviposition cage, so that mass parasitism was obtained, this number was increased to 200 or more. Screen-bottomed trays were substituted for vials for incubating the parasitised host larvae. In addition to saving time, their use obviates the need for handling the puparia, in the course of which the latter were frequently injured and thus rendered susceptible to attack by disease organisms; survival during 1945–46 was increased by some 20 per cent. The compactness of the cages enabled large numbers of parasites to be bred in a relatively small space, and the number available for release was increased from 20,000 or less per season to 150,000 during 1945 and 1946. Fungi are liable to develop on liquid food in contact with the wooden parts of a cage, and some insect species are harmed by food contaminated in this way. This disadvantage was overcome by presenting the food (honey absorbed on pieces of dental roll) in cartridges fitted into a specially constructed board; these, if properly handled, eliminate the possibility of spilling and their removal does not disturb the insects.

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